Task/Subtask IV02.1
CDRL Sequence A014–010
6 March 1995

SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM

Technical Papers: Defining Manually Enactable Processes Using the Process Definition Information Organizer Templates

Contract No. F19628–93–C–0129
Task IV02 – Megaprogramming Transition Support

Prepared for:

Electronic Systems Center
Air Force Materiel Command, USAF
Hanscom AFB, MA 01731–2116

Prepared by:

Loral Federal Systems
700 North Frederick Avenue
Gaithersburg, MD 20879

19950403 141

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William H. Ett, Loral Federal Systems
Dick Phillips, Jim Over and Marc Kellner, Software Engineering Institute

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Loral Federal Systems
700 North Frederick Avenue
Gaithersburg, MD 20879

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This document consists of the presentation slides to be used as a tutorial at the 1995 SEPG Conference to be held in Boston, MA on May 22-25, 1995. This tutorial will cover planning for the definition of a project's processes, an approach for defining manually enactable processes, and an approach for evaluating process definition results.

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Preface

This document was developed by the Loral Federal Systems - Gaithersburg, located at 700 North Frederick Avenue, Gaithersburg, MD 20879. Questions or comments should be directed to Mr. William H. Ett at 301-240-6337 (Internet: ettb@lfs.loral.com).

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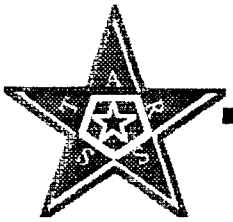

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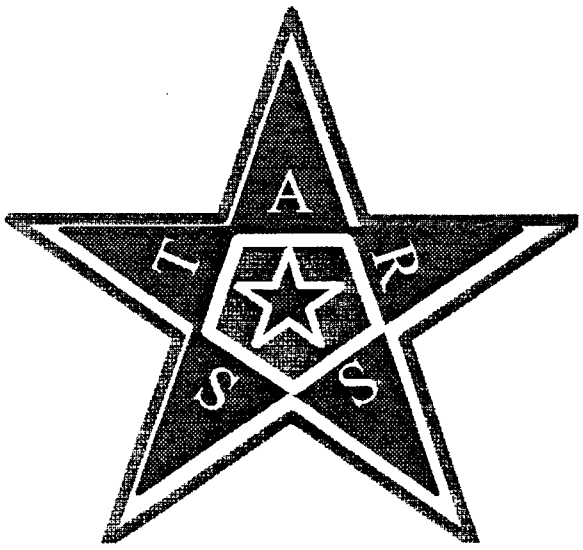
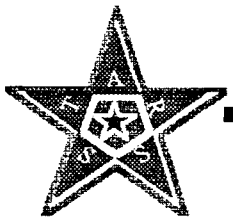
1995 SEPG Conference
Boston, Massachusetts
May 22-25, 1995

Tutorial:
Defining Manually Enactable Processes Using the Process Definition Information Organizer Templates



Prepared by:
William H. Ett, Loral Federal Systems
Dick Phillips, SEI
Jim Over, SEI
Marc Kellner, SEI



Support for the preparation of materials for this tutorial was provided by the ARPA Software Technology for Adaptable, Reliable Systems (STARS) Program under the Loral STARS V02 Technology Transition task. Support was also provided by Dick Phillips, Jim Over and Marc Kellner of the SEI, through the collaboration of the SEI's Process Definition Project with the STARS prime contractors and the STARS service demonstration projects. The authors would like to express their appreciation to John Foreman, STARS Program Manager, for his support of this tutorial.

Defining Manually Enactable Processes Using the Process Definition Information Organizer Templates

William H. Ett
Loral Federal Systems, STARS Program

Marc Kellner
Software Engineering Institute

Richard W. Phillips
Software Engineering Institute

Jim Over
Software Engineering Institute

Tutorial Contents

★ 1 - Introduction
2 - Process Definition Concepts
3 - Planning the Project Process

Definition
4 - Process Context
5 - Process Layout Specification
6 - Process Design Specification
7 - Process Enactment Information Specification

Evaluation
8 - Evaluating Process Definition Results

Introduction

Who Should Be Here?

Professionals that:

- **Define and reuse processes that need to be both understandable and enactable (or executable)**
  - **work, system, utility/service processes ...**
- **Tailor organization processes to address the needs of their software development projects**
- **View processes as part of their transferrable knowledge base on how they expect to conduct business**

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What Will We Cover?

Planning for the definition of a project's processes

- Defining requirements for the project's process
- Defining the project's process architecture

An approach for defining manually enactable processes

- Laying out the process
- Describing methods, resources, and artifacts
- Describing the work actions of every enactable process
- Packaging the enactable process

An approach for evaluating process definition results

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What Will You Walk Away With?

Techniques that can be applied to:

- Plan your process definition efforts
- Define manually enactable processes
- Evaluate your process definitions

A copy of :

- "*Instructions for Process Definition Information Organizer Templates*"
- Template skeleton

Agenda

08:00 AM Introduction
08:10 AM Concepts and Process Definition Planning
09:20 AM Process Context and Layout Specification
10:30 AM Break
10:40 AM Process Design & Enactment Specification
11:40 AM Process Definition Evaluation
11:55 AM Discussion
12:00 PM Adjourn

Contributors

SEI Software Process Definition Project

- Mr. Paul G. Arnold, Loral FS (RA)
- Dr. James W. Armitage, GE (RA)
- Mr. Salvatore DiGenarro, NAWC (RA)
- Ms. Linda P. Gates, SEI
- Dr. Marc Kellner, SEI
- Dr. Warren Moseley, TI
- Ms. Julia Mullaney, SEI
- Mr. Kenneth Y. Nieng, AT&T (RA)
- Mr. Timothy G. Olsen, SEI
- Mr. James W. Over, SEI
- Mr. Richard W. Phillips, SEI
- Mr. Neal Reizer, SEI

ARPA STARS

Air Force Demonstration Project

- Mr. William H. Ett, Loral FS
- Maj. Dominique Guay, CF
- Capt. Barb Kubes, USAF
- Lynn Underhill, Loral FS

Navy Demonstration Project

- Dr. James E. King, Boeing
- Mr. Mark Kasunic, Boeing

Army Demonstration Project

- Marlene Pickel, Army
- Ms. Carol Klingler, Unisys
- Dr. Jerry R. Pixton, Unisys

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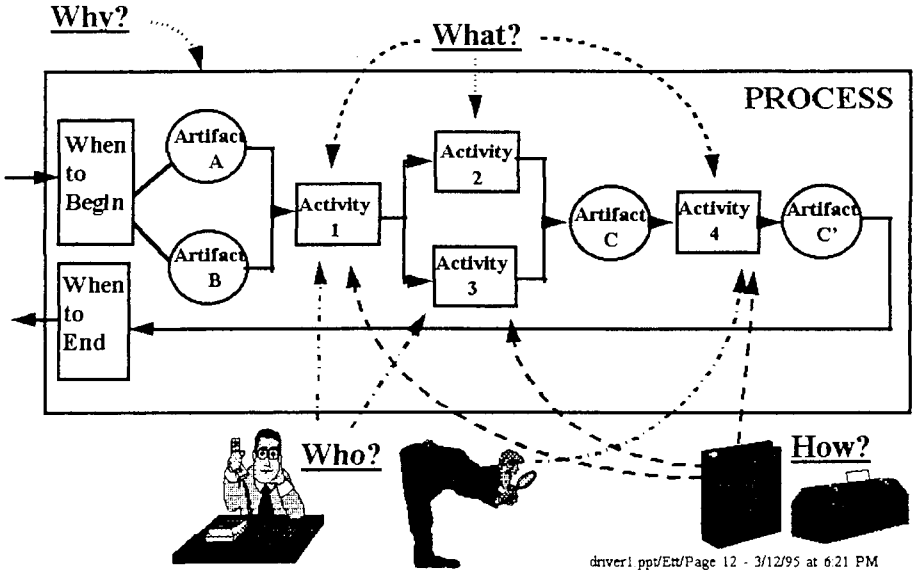
Process Definition Concepts

Process Definition Concepts

Concepts

- **Process Definition Elements**
  - Activities, Artifacts, Agents
  - Methods and Entry/Exit Criteria
- **Two Life Cycles Model for Process Definition**
- **Process Definition Activities**
- **Process Definition Products**

Process Definition Elements

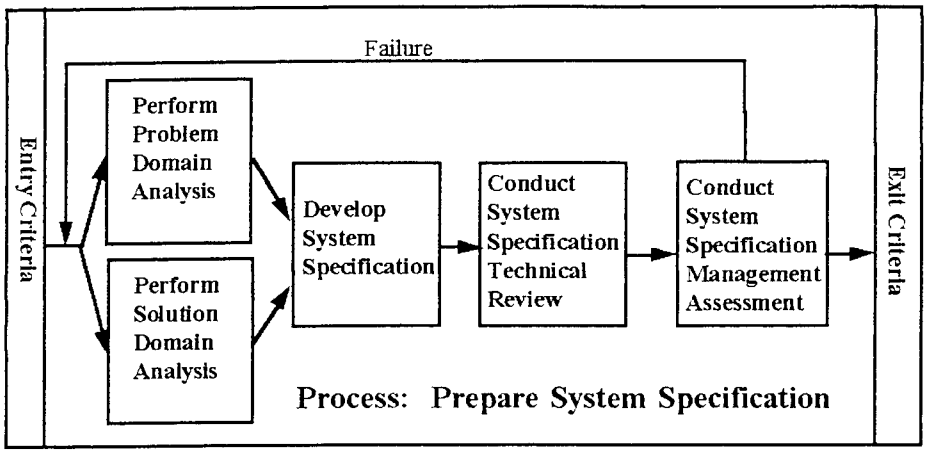


Process Context

Why?

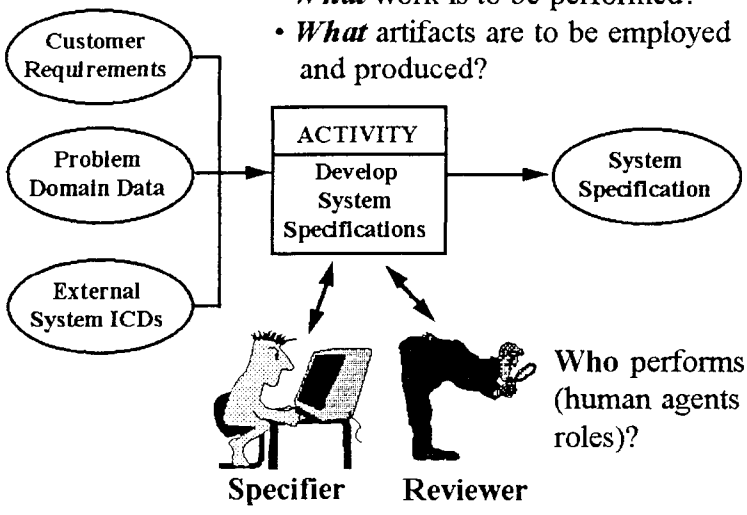
Why ***this*** process?

- *What* are the requirements for the process?
- *What* is the purpose of the process?



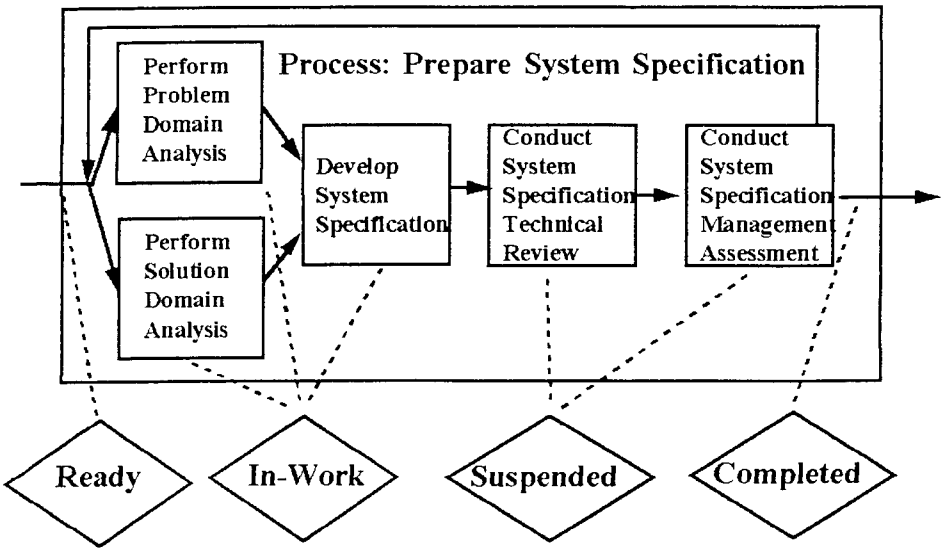
Activities and Agents

- ***What*** work is to be performed?
- ***What*** artifacts are to be employed and produced?

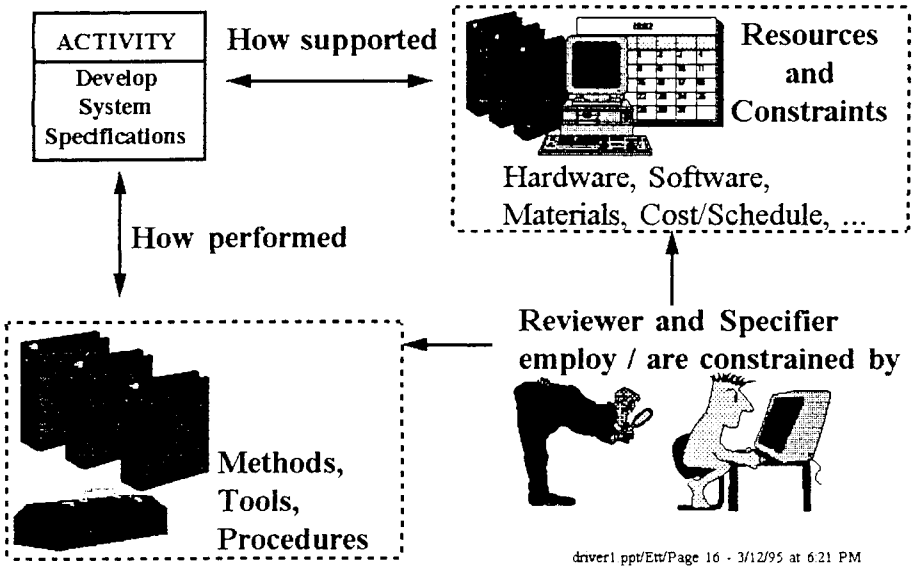


Who performs the activity (human agents and their roles)?

Activity States



Methods and Resources

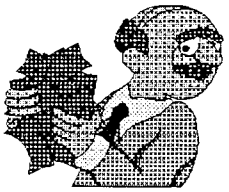


Entry/Exit Criteria

Conditions under which an *activity*:

1) should begin:

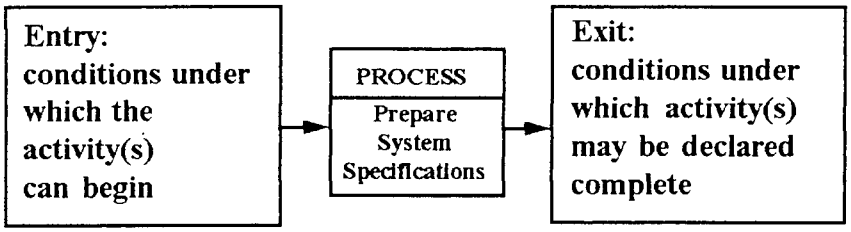
- Artifact states
- Completion of predecessor activities
- Resource availability



2) may be declared "complete:"

- Artifact states
- Completion of other related activities
- Returns from methods
- Checklist completion

When

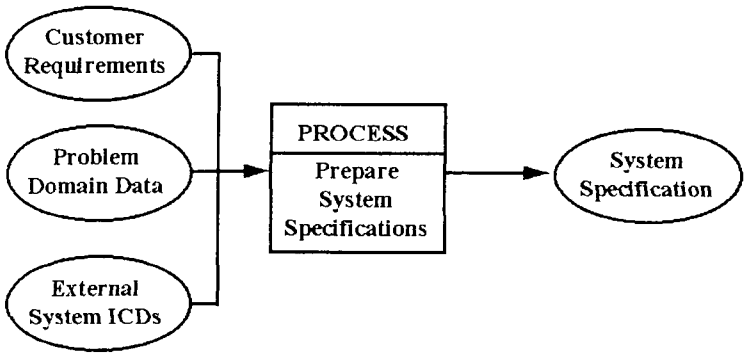


If "Customer Requirements" and "External System ICDs" are available,
Then
begin "Prepare System Specifications"

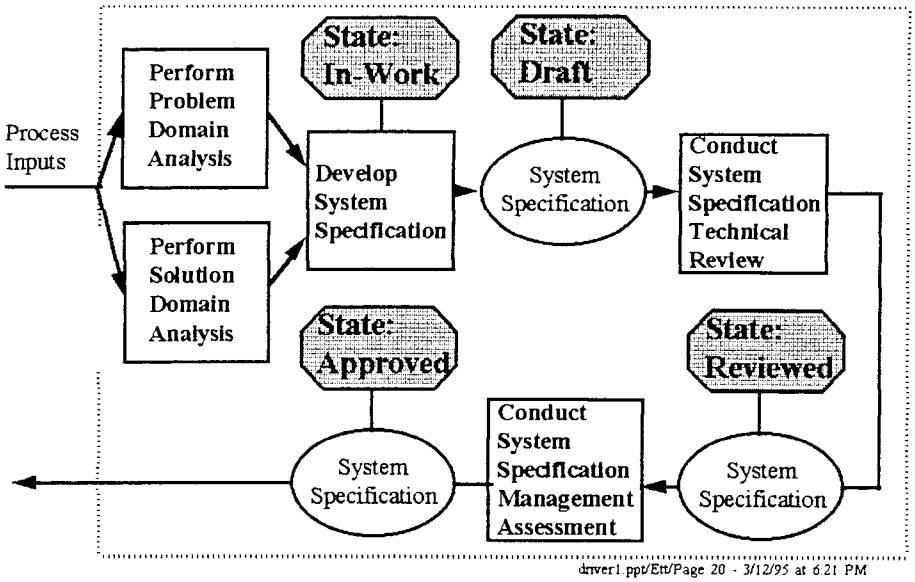
If "System Specifications" has state of "approved,"
Then
log "Prepare System Specifications" as "completed"

Artifacts

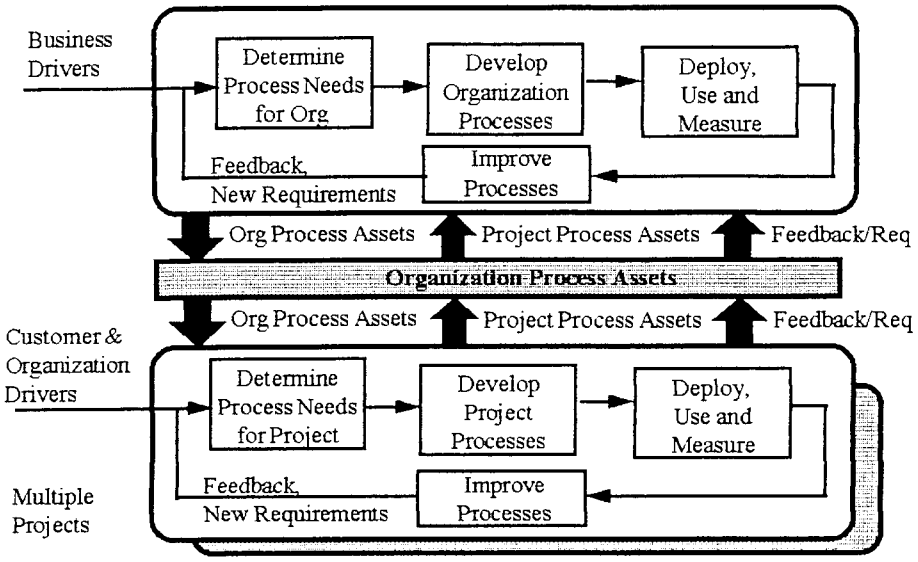
- Used or produced by a process
- Are activity inputs and outputs
- May have states and allowable state transitions



Artifact States



Two Life Cycle Concept for Process Definition



Why the Two Life Cycles for Process?

Organization Focus

- **Organization processes as "Product Line"**
  - Standard Business processes
  - Standard technical, service and utility processes
  - Process analysis and improvement
- **Processes defined to:**
  - Support the organization's business requirements
  - Ensure consistency and quality of products / work results
  - Address process assurance criteria required by customer set

Why the Two Life Cycles for Process?

Project Focus

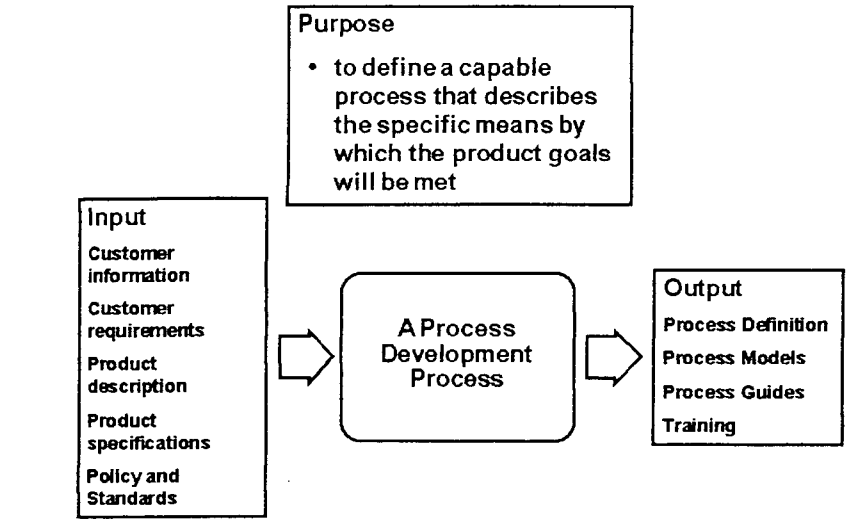
- **Project process concerns - Customer / Developer**
  - Processes that demonstrate developers can deliver
  - Processes that address customer's requirements
  - Processes that address customer's quality concerns
  - Processes that also address organization requirements
  - Processes must reflect how work is to be performed
    - Different application domains
    - Different domain and technical maturity
    - Technology adoption and use

CMM V1.1 Mapping to Cleanroom

Exercise illustrated key differences of the "project process" and "organization processes"

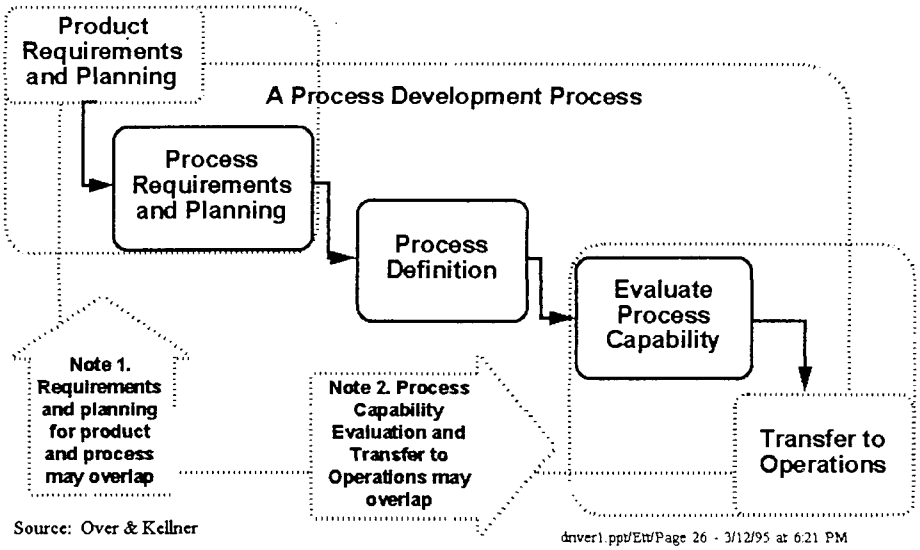
- *Organization processes* developed to address process assurance criteria of the CMM
  - Software project management processes
  - Technical service processes
- *Cleanroom Process* - prepared specifically to support the *technical management* and development of software projects:
  - Life cycle specific way of doing business
    - Defect prevention
    - Statistical usage testing

A Process Development Process



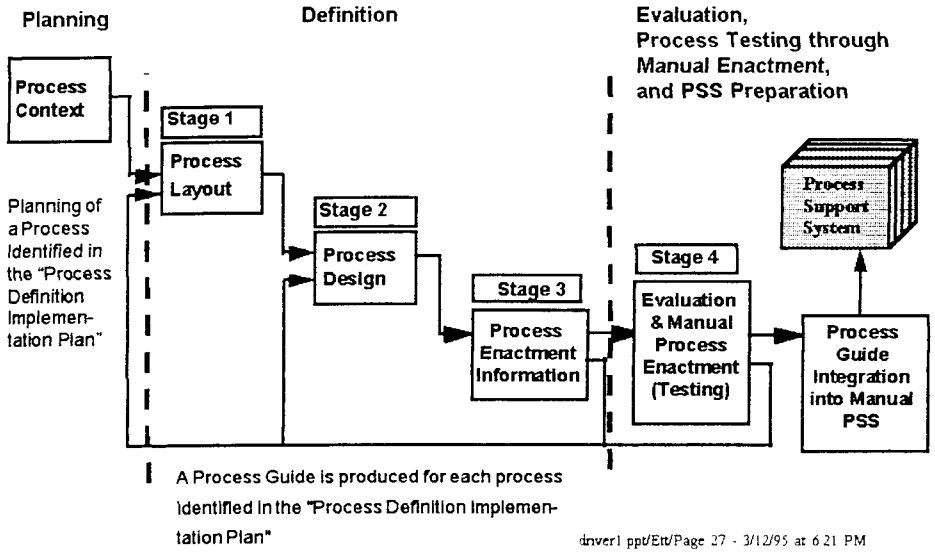
Source: Over & Kellner

Process Development Activities

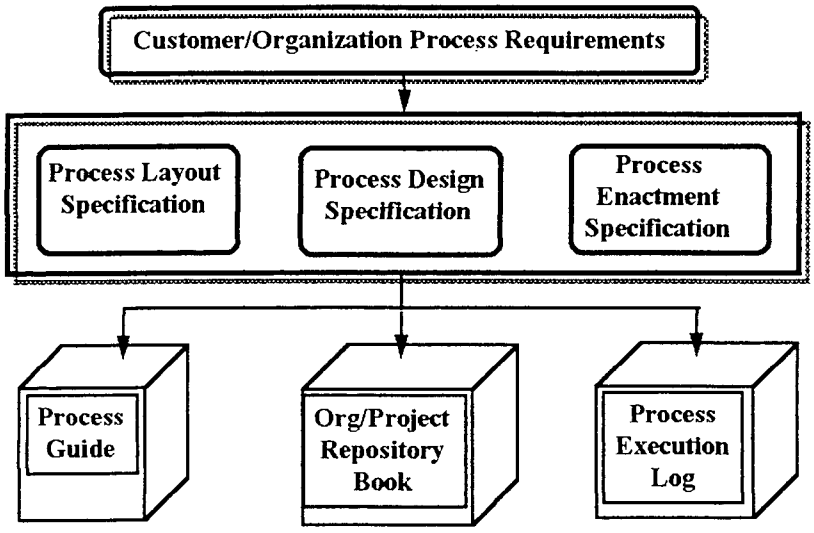


Source: Over & Kellner

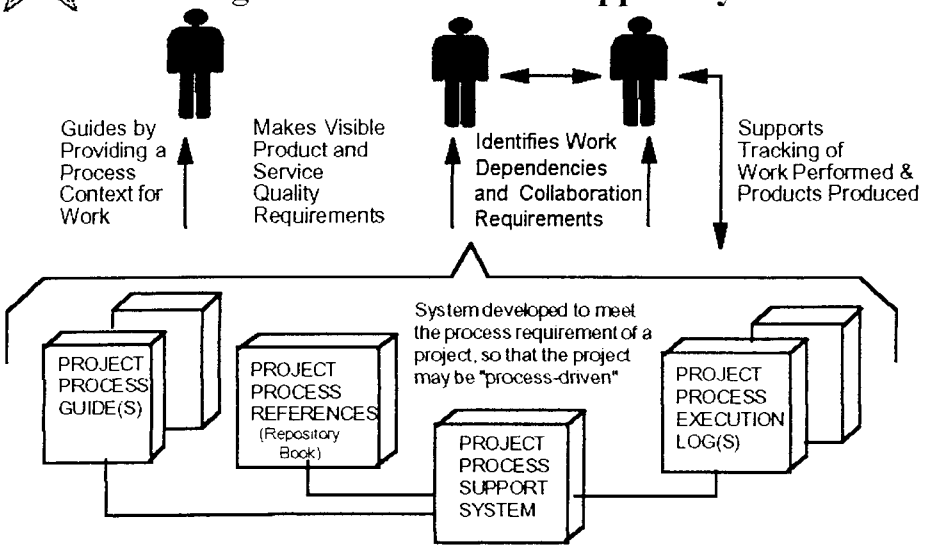
Process Definition, Evaluation & Use



Process Definition Products



Defining a Manual Process Support System



Note: Figure Depicts a Manual Process Support System for a Project

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Process Definition Planning

Process Definition Planning

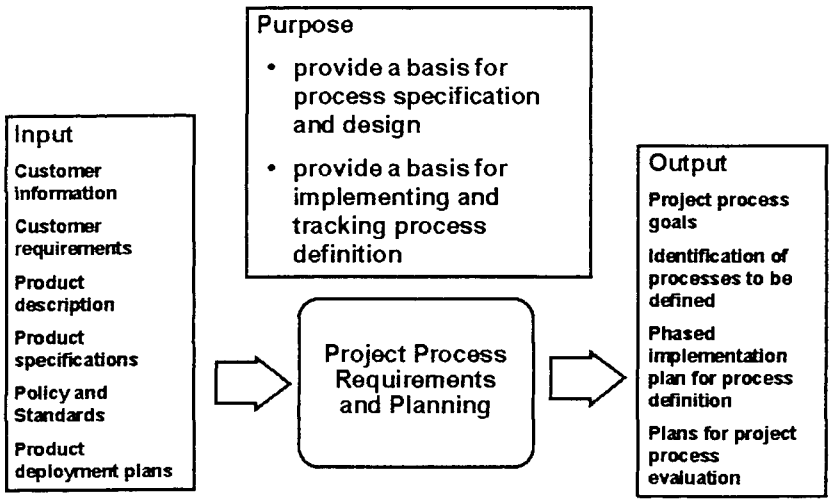
Concepts

- Analyzing the Requirements for the Project Process
- Preparing the Project Process Architecture
  - SCAI Project Example
- Preparing the Phased Definition Plan
- Using the Process Architecture to Support Process-Driven Project Planning

Focus

- Project Process Definition
- Approach applied on the Air Force STARS Demonstration Project

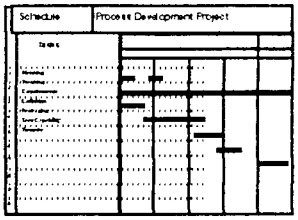
Project Process Requirements & Planning



Process Definition as a Project Activity

Project process definition is a vital part of an engineering project and must be planned

- Process Definition efforts may be organized as a project within a project
  Examples:
  - process action teams
  - business process re-engineering

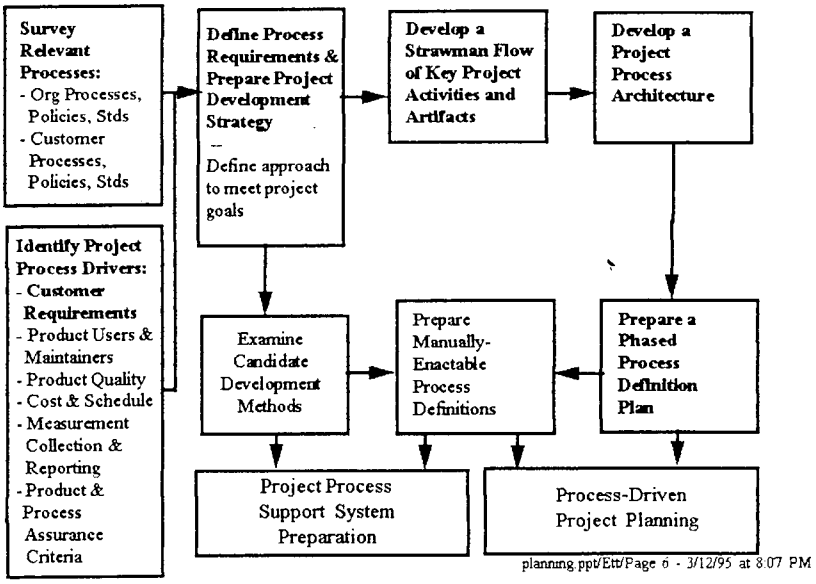


Successful process definition efforts:

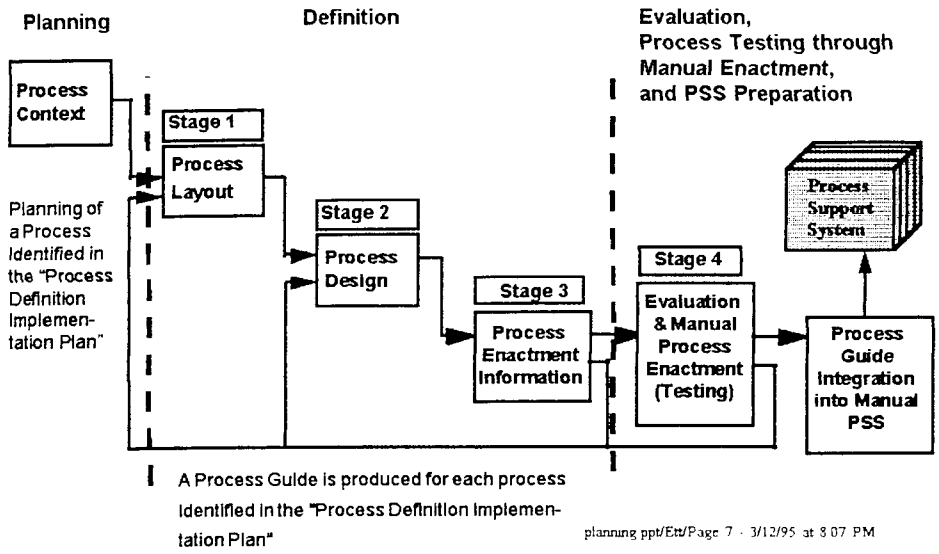
- are planned and tracked
- follow a defined process as the basis for planning
- are staffed, reviewed, approved, etc.

Source Over-94

Planning for Process Definition



Process Definition, Evaluation & Use



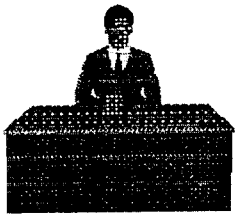
Survey Relevant Processes

Project process definition teams must identify what processes have been defined

Potential Sources:

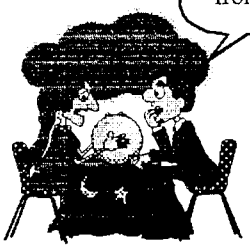
- Site SEPG
- SEI:
  - SEI Software Process Frameworks for levels 2 through 5 (ETVX description of each CMM V1.1 KPA)
- STARS *ASSET*:
  - Keeper of the SEI/STARS Process Assets
    - Cleanroom Process Guidebooks
    - Ada Process Model Guidebook
    - AT&T Quality Function Deployment Process
- Customer:
  - Standards and Product DIDs

Identify Project Process Drivers

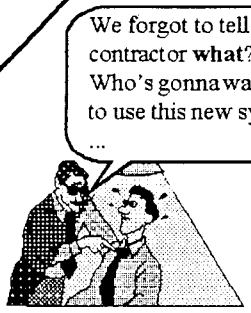


- Product/system requirements
- Cost
- Schedule
- Customer processes, policies, and development standards
- Customer's definition of product quality
- Developer Process Assurance

- Organization processes, policies, practices, standards, methods, etc

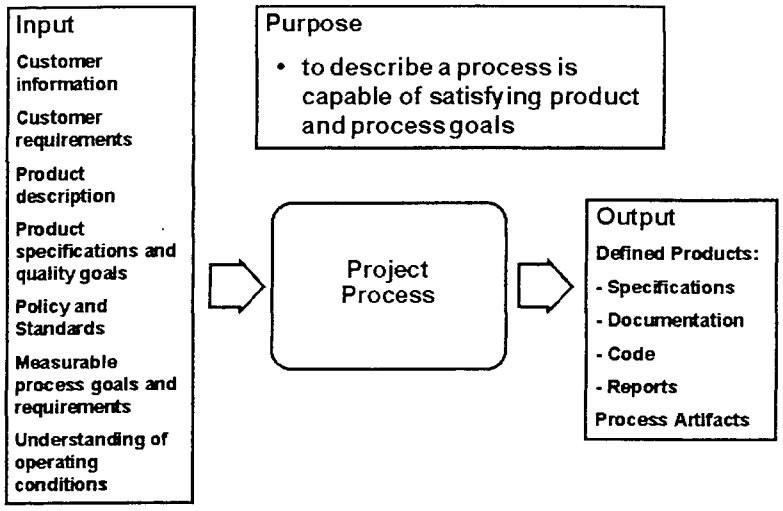


Identify Project Process Drivers



- Operating environments
- How and where the target system will be used
- How the target system will be maintained and by whom

Defining Project Process Requirements

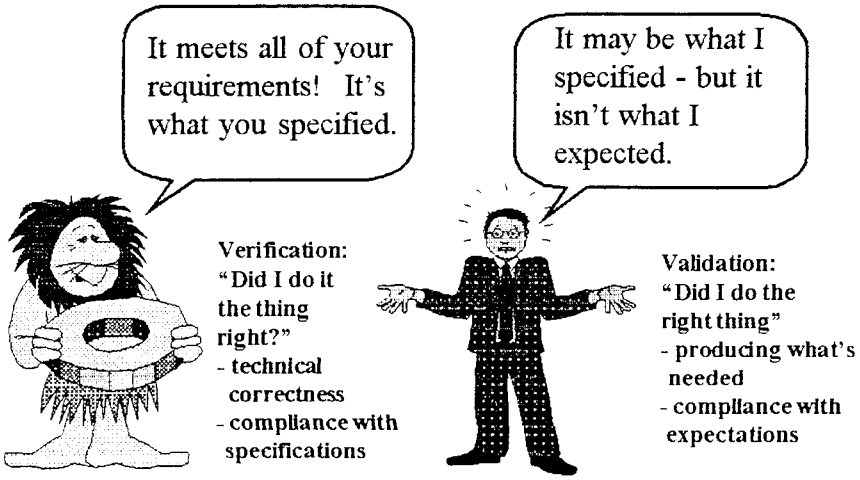


Defining Project Process Requirements

Requirements for the Project Process:

- How will we *verify and validate* the specified work products?
  - Verification - Is our work *technically correct*?
  - Validation - Is the system we built *what the customer wanted*?
- How will customer and contractor management *assess* work progress?
- How and when will status be *reported* to support project control?
- What *measurements* must be taken and what *metrics* must be computed? How will they be reported and when?

Verification and Validation Requirements: A Project Process Concern



Verification:
"Did I do it the thing right?"
- technical correctness
- compliance with specifications

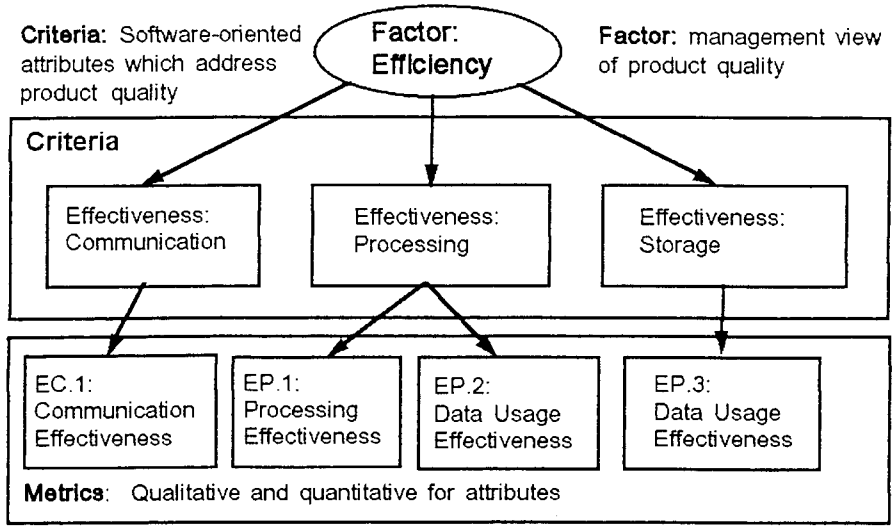
Validation:
"Did I do the right thing"
- producing what's needed
- compliance with expectations

RADC Quality Framework

Criterion \ Factors	Efficiency	Integrity	Reliability	Survivability	Usability
Accuracy			X		
Anomaly Mgt			X	X	
Autonomy				X	
Distributedness				X	
Effectiveness: Comm.	X				
Effectiveness: Proc.	X				
Effectiveness: Stor.	X				
Operability					X
Reconfigurability				X	
System Accessability		X			
Training					X

This table illustrates a portion of the RADC quality framework factors and associated criteria. Factor/criteria paring is used to identify data collection forms and associated metrics for use in process instrumentation.

RADC Quality Framework



Prepare Project Development Strategy

Risk Factors:

- **Problem domain understanding**
- **Technology maturity**
- **Precedence with respect to past systems**
  - **Unprecedented (first time out)**
  - **Precedented (instances have been built**

Development Approaches Selected to Manage Risk:

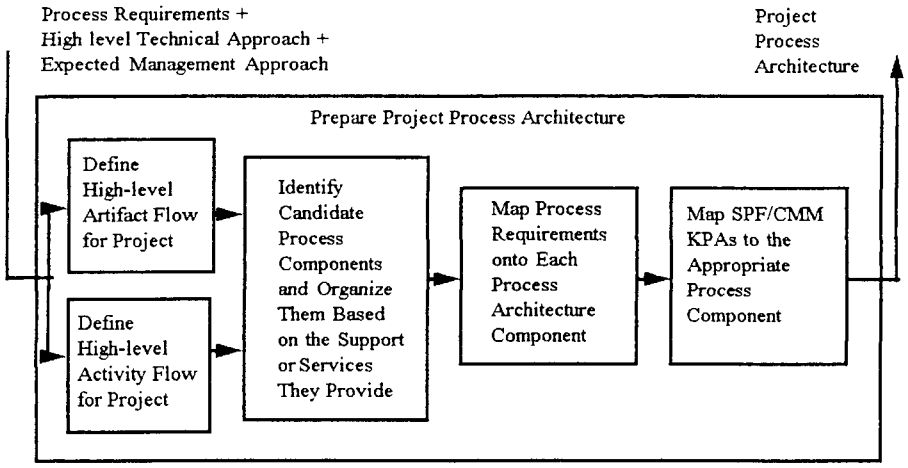
- **Spiral framework**
  - **Prototyping**
  - **Incremental development**
- **Waterfall framework**

Defining the Project Process Architecture

What is a "Project Process Architecture"
A framework of the process components required to satisfy a project's process requirements

The "Project Process Architecture" defines:
- The components of the project process and their relationships from a "black box" perspective:
  - Process components inputs and outputs
  - Process component black box behavior
- The interfaces between process components

Defining the Project Process Architecture

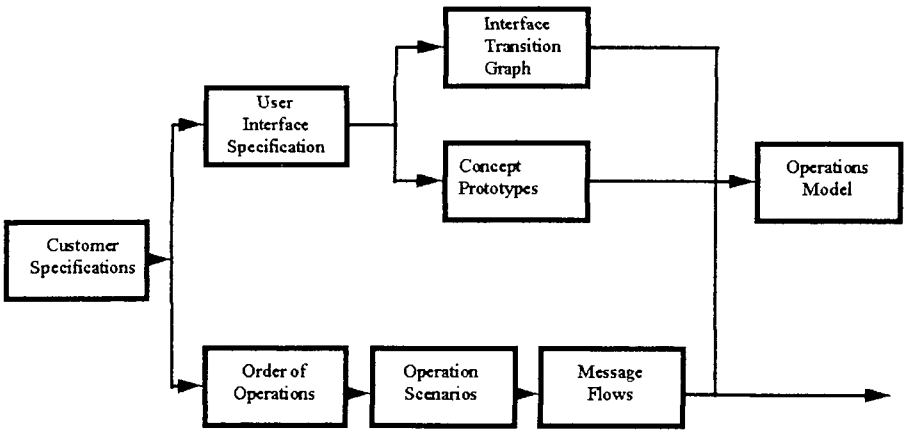


Defining the Project Process Architecture

After the "Project Process Architecture" is defined, it becomes the basis for:

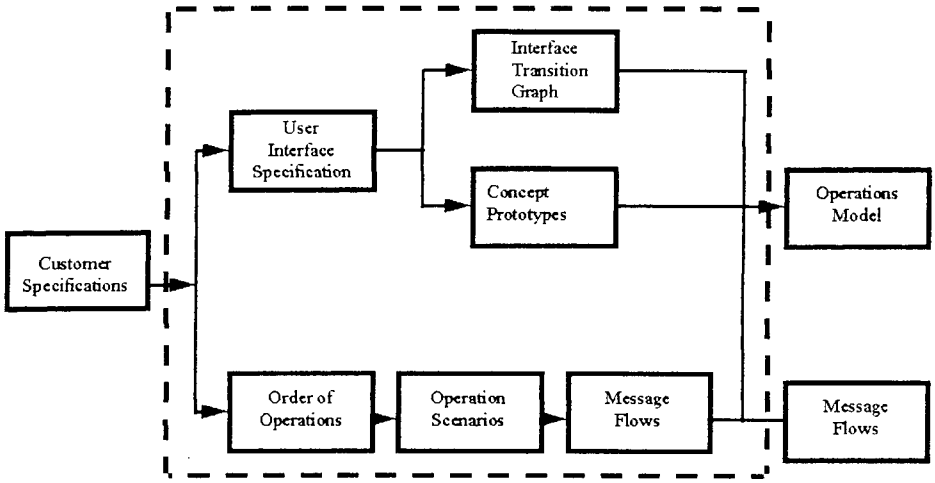
- **Process Definition Planning**
  - Understand what processes to reuse, tailor or develop
  - Basis for phasing the definition of project processes
- **Process Requirements Allocation**
- **Process Assurance Planning**
  - Understand which process components must address SEI CMM V1.1 or ISO-9000.2 criteria

Artifact flow for preparing an "Operations Model"



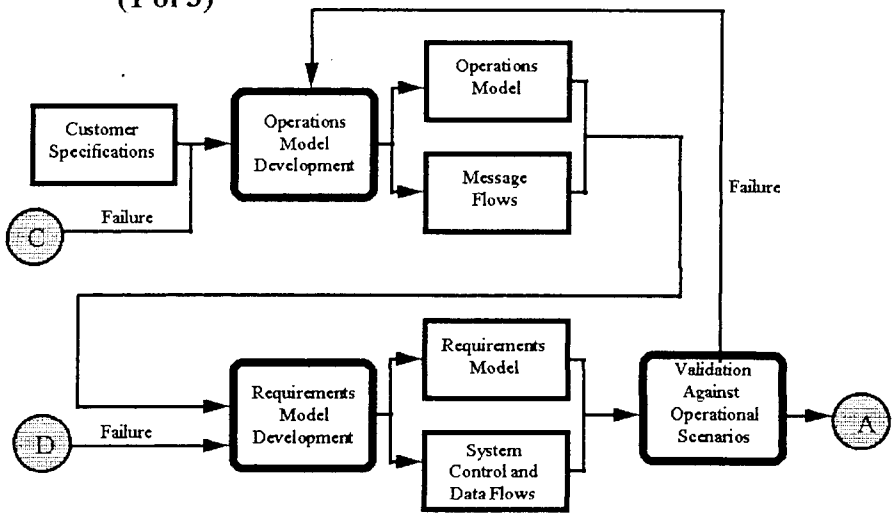
Example from "Developing with Ada. Life Cycle Methods" by Bruce E. Krell. Bantam Professional Books

Process Component: "Operations Model Development"



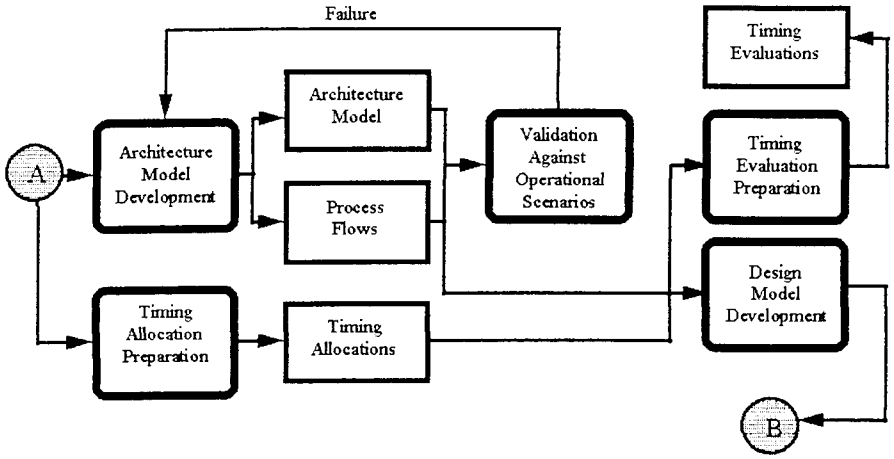
Example from "Developing with Ada: Life Cycle Methods" by Bruce E. Krell. Bantam Professional Books

Activity Flow: "Ada R/T Software Engineering Process" (1 of 3)



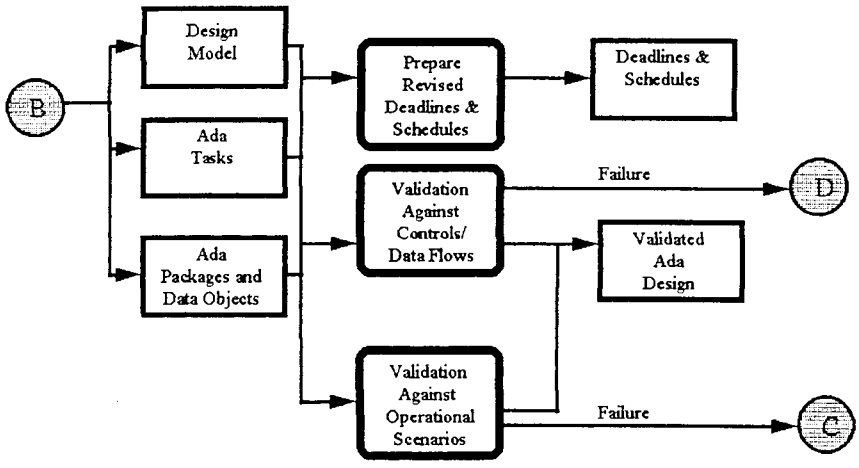
Example from "Developing with Ada: Life Cycle Methods" by Bruce E. Krell. Bantam Professional Books

Activity Flow: "Ada R/T Software Engineering Process" (2 of 3)



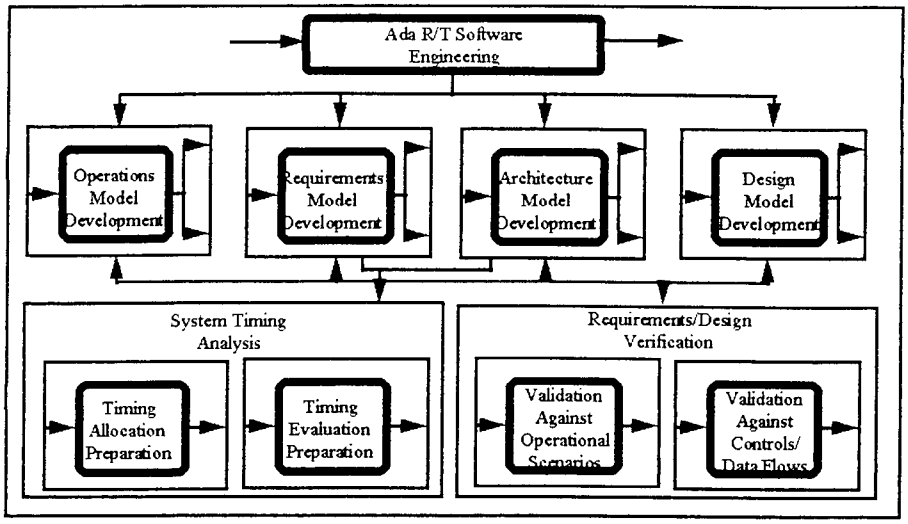
Example from "Developing with Ada: Life Cycle Methods" by Bruce E. Krell. Bantam Professional Books

Activity Flow: "Ada R/T Software Engineering Process" (3 of 3)



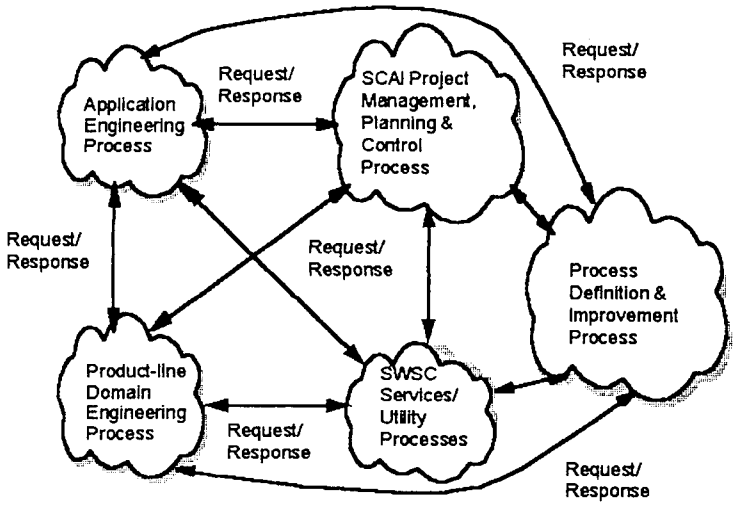
Example from "Developing with Ada: Life Cycle Methods" by Bruce E. Krell. Bantam Professional Books

Process Architecture

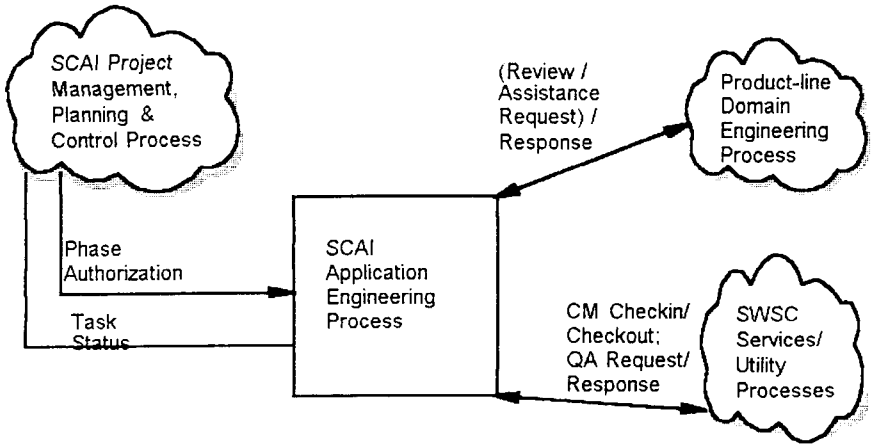


Example from "Developing with Ada: Life Cycle Methods" by Bruce E. Krell. Bantam Professional Books

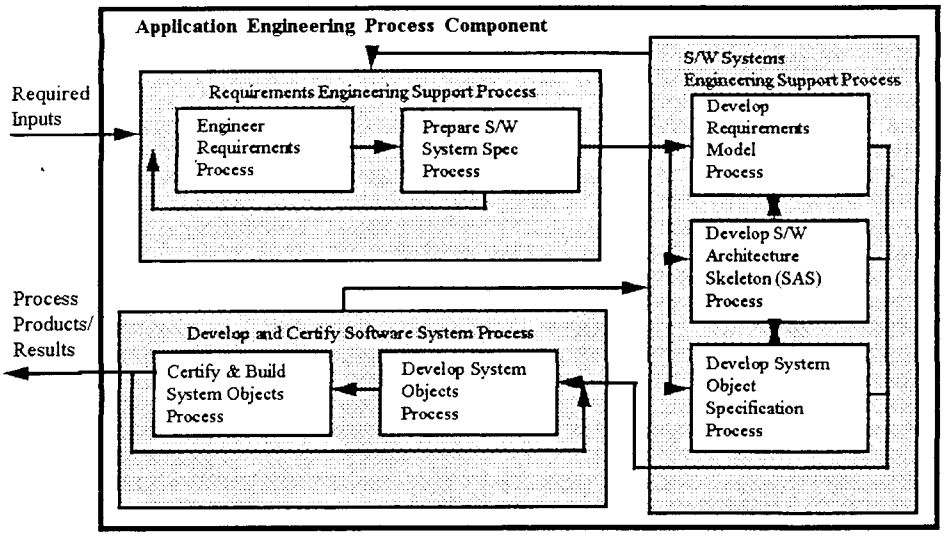
SCAI Process Architecture Concept



SCAI AE Development Strategy



SCAI Application Engineering Process

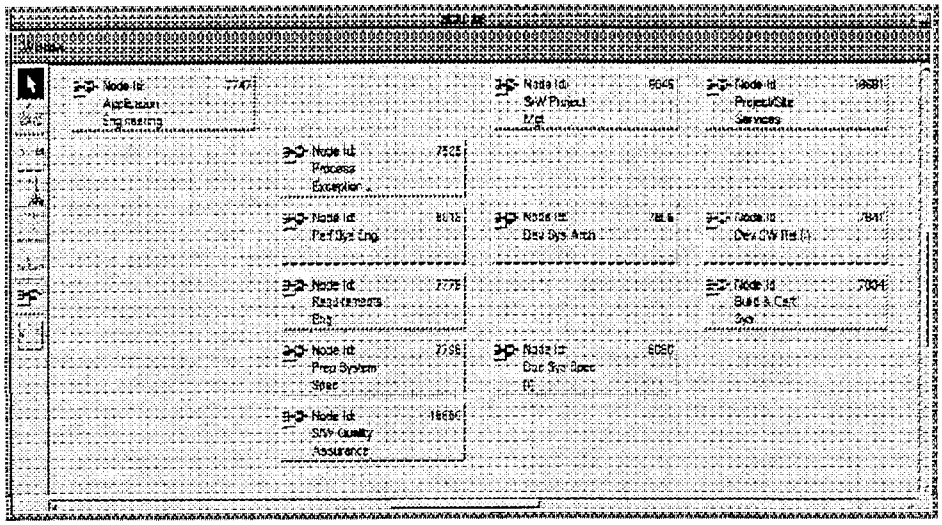


Phased Process Definition Plan

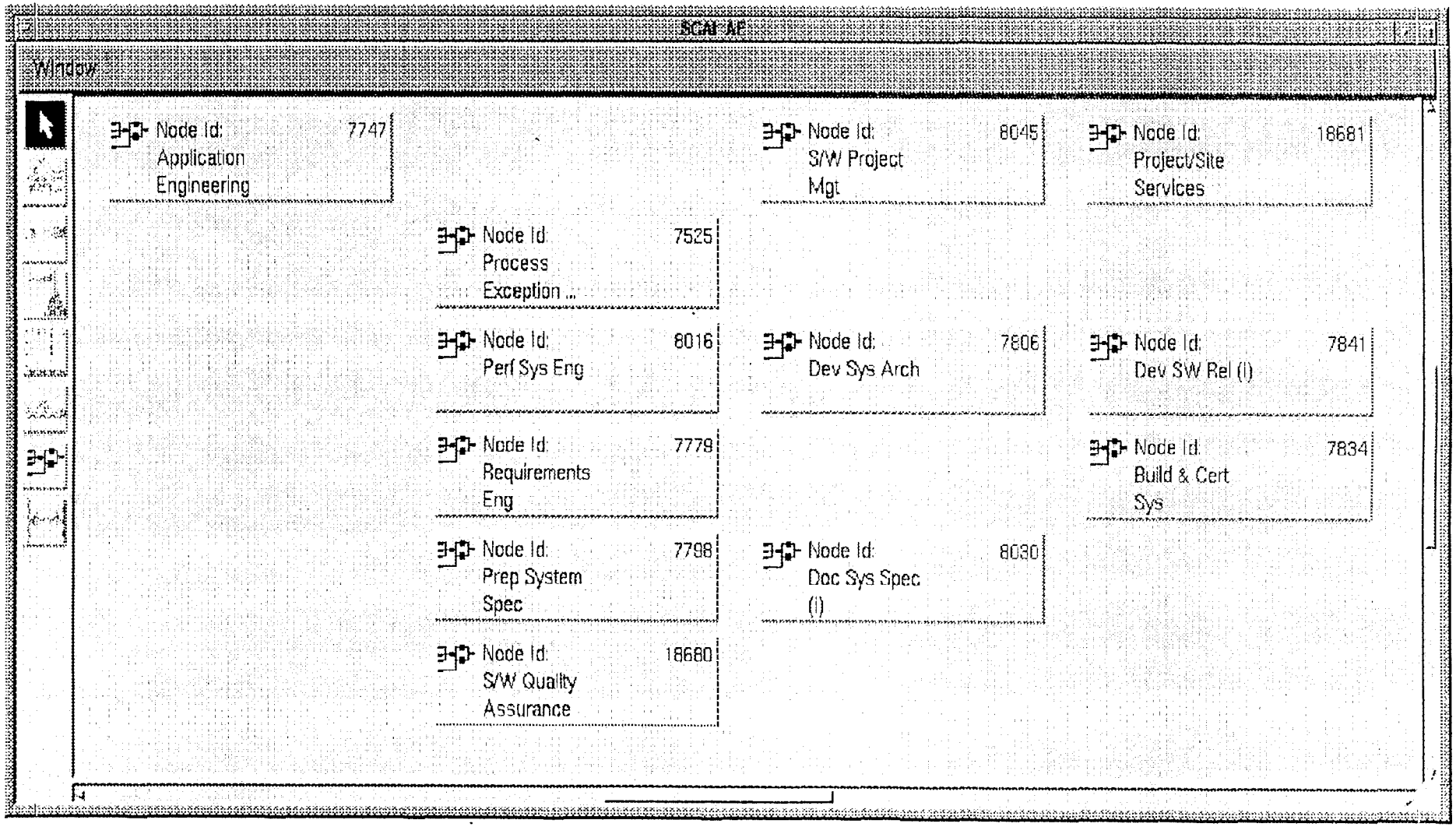
Preparation Phase	Processes Required to Support Work Increments
SCAI Increment 1 (90 days prior to project start)	o Requirements Engineering Process (OBE) o System Specification Development Process o SAS Development Process o Requirements Model Development Process
SCAI Increment 2 (120 days prior SCAI release 1 development)	o System Object Specification Development Process o System Object Development Process o System Object Certification Process
SCAI Increment 3 (120 days prior to SCAI release 2 development)	o System Object Integration & Build Process o System Certification Process (Outside of AEP) ...

Example from the SCAI Project "Phased Process Definition Plan " for Application Engineering

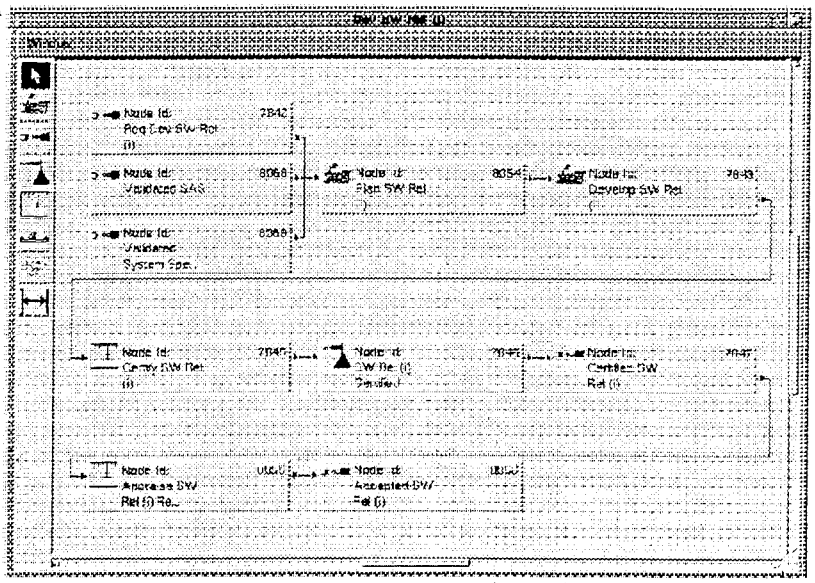
Process Driven Project Planning (1)



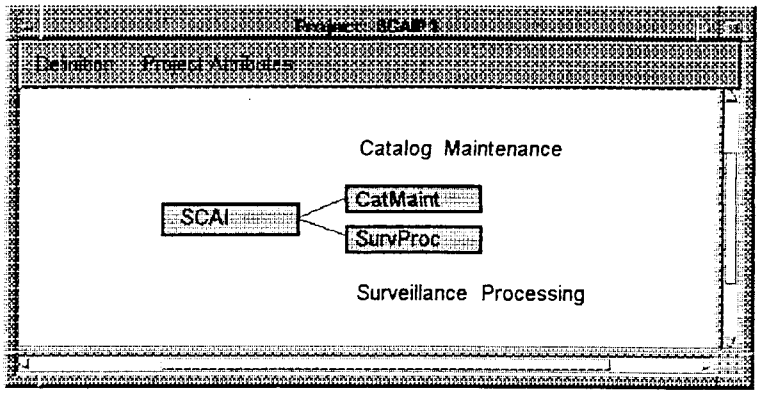
Process Driven Project Planning (1)



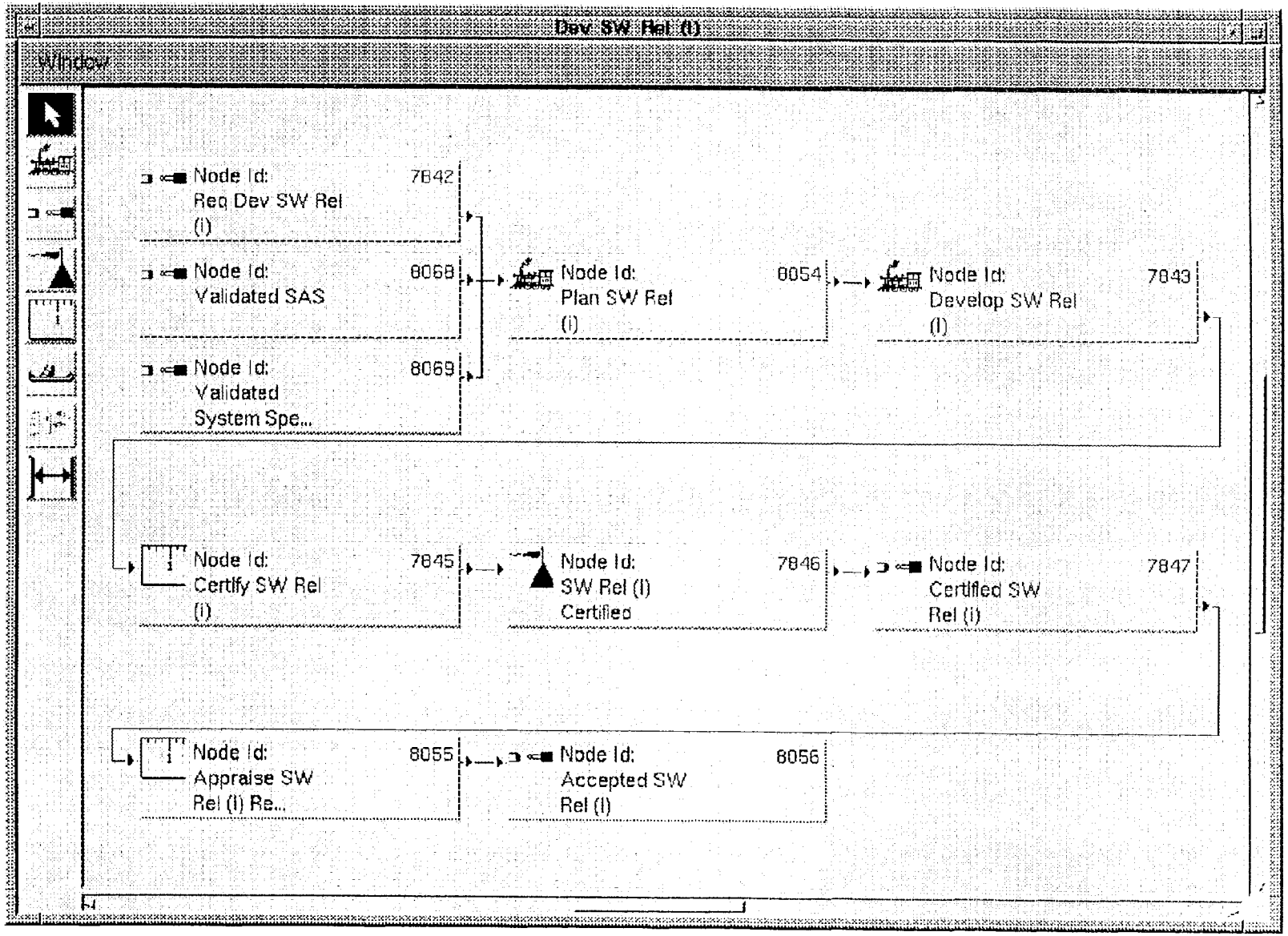
Process Driven Project Planning (2)



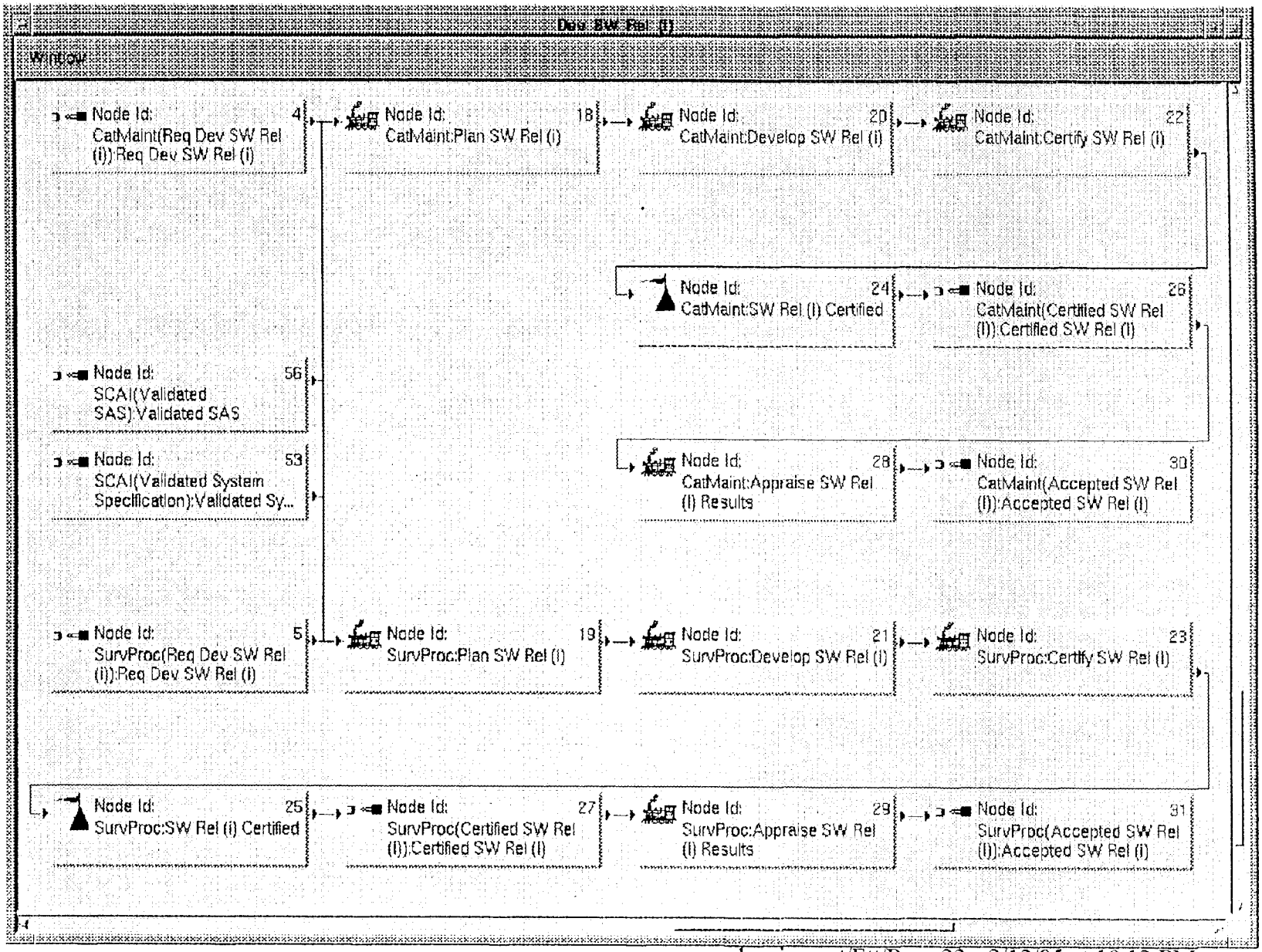
Process Driven Project Planning (3)



Process Driven Project Planning (2)



Process Driven Project Planning (4)



Tutorial Contents

1 - Introduction
2 - Process Definition Concepts
3 - Planning the Project Process

Definition

★ 4 - Process Context
5 - Process Layout Specification
6 - Process Design Specification
7 - Process Enactment Information Specification

Evaluation

8 - Evaluating Process Definition Results

STARS Program
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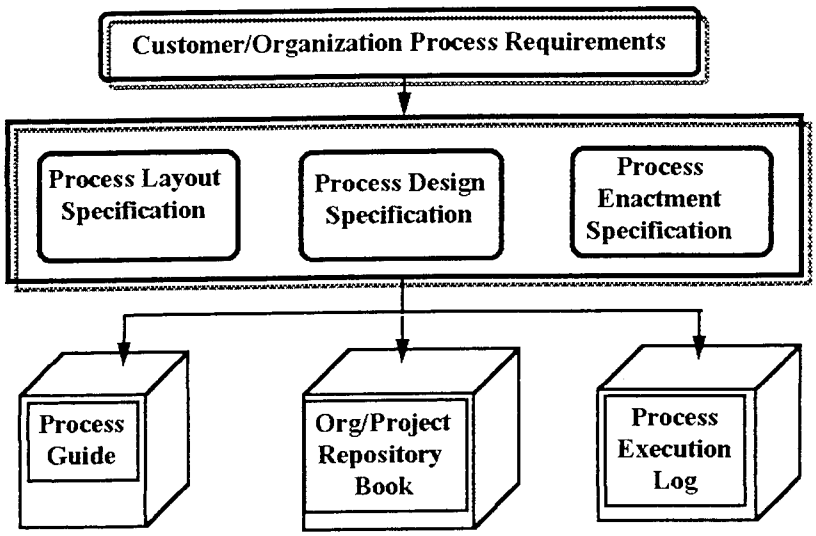
Process Context

Process Definition Products



Process Context & Requirements Definition

Purpose

- define process purpose and goals
- define relationship to other processes
- define requirements and measurable goals
- define conditions under which the process will operate
- provide a basis for process evaluation

Input

- Phased process definition plan
- Customer information
- Customer requirements
- Product description
- Product specifications
- Policy and Standards

Define Process Context and Requirements

Output

- Process purpose and measurable goals
- Process requirements
- Process operating conditions
- Plan for definition and evaluation

STARS Program
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Process Context

Process Guide

Process Context Section

Overview:

Process Purpose:
- What will following this process accomplish?
- Does following this process satisfy its intended purpose?

Process Goals:
- Goals this process addresses

Process Context:
- Relationship of this process with others

STARS Program
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Process Context

Process Guide

Process Context Section (Continued)

Process Requirements:

Required Inputs (Artifacts, messages, controls, etc.)

Process Work Results (Products and services)
- **Quality attributes** of each work product and service

Measurement requirements
- Process measurements and metrics
- Product measurements and metrics

Reporting Requirements
- Normal reporting and exception reporting

Process Context: Artifact Quality Attributes

Product	User Product Quality Factor	Product Quality Criteria
Space Catalog Software Component	Reliability	Accuracy Simplicity
	Usability	Operability Training
	Correctness	Completeness Consistency Testability Traceability

Process Context

Organization/Project Repository Book

Process Context Section (Continued)

Process Operating Environment:

Process Audience:
- Who (roles) are the intended users of this process?
- What are their current responsibilities?

Process Usage:
- How will each audience use this process definition?

Benefits:
- What benefits will users realize after using the process?

Source: "Developing Useful Documents," American Institute for Research, 1990 layout ppt/Ett & Phillips/Page 8 - 3/12/95 at 8:55 PM

Process Context

Organization/Project Repository Book

Process Context Section (Continued)

Process Audience and Experience:

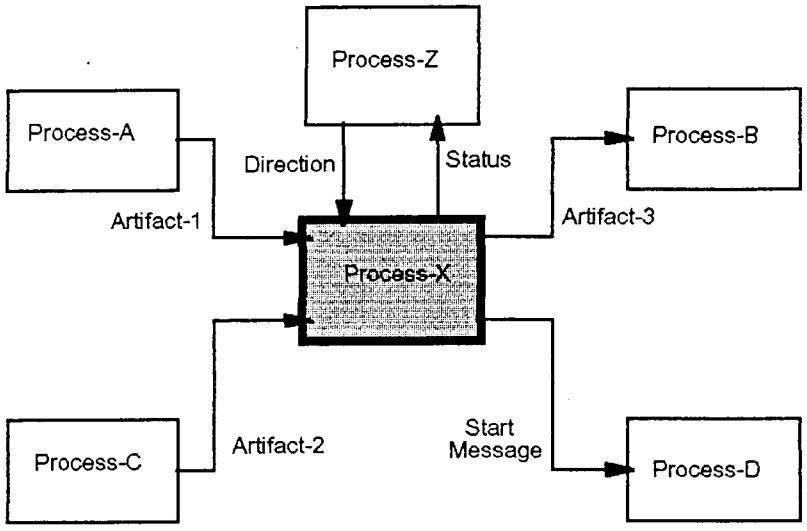
- How new is what you are telling them?
- What vocabulary do they use?
- How do they think about this topic or the tasks involved?
- What do they need to know before using the process

Process Audience Motivation:

- How much effort are they willing to put into learning understanding what the process definition requires of them?

Source: "Developing Useful Documents," American Institute for Research, 1990

Process Context



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Next Step: Process Layout

- Complete process context for assigned process
- Identify and define artifacts
- Define agent roles
- Graphically depict process layout
- Verify that activity and artifact granularity is OK

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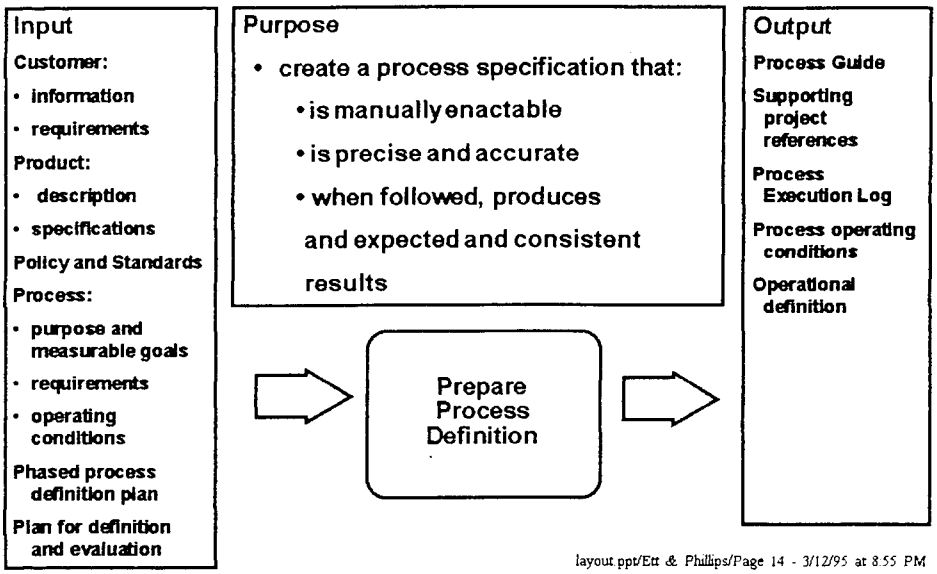
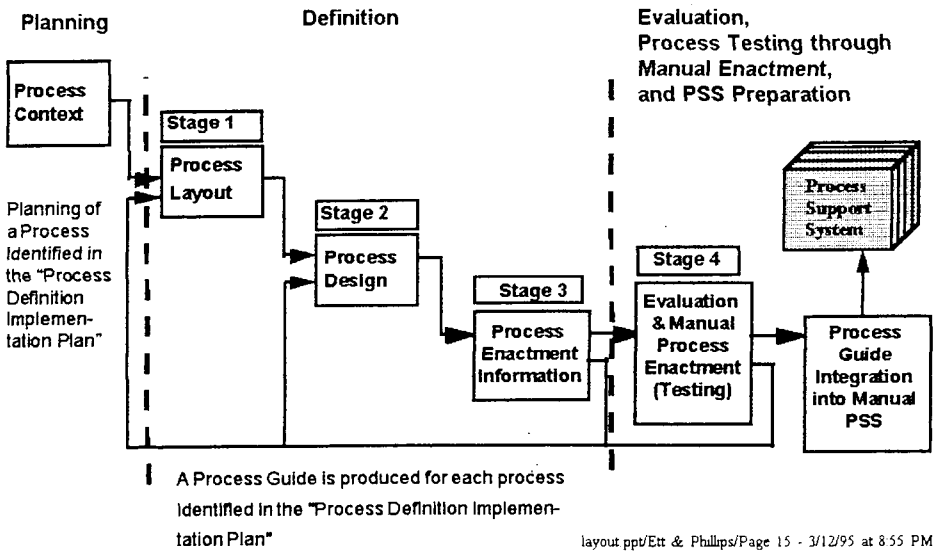
Process Layout Specification

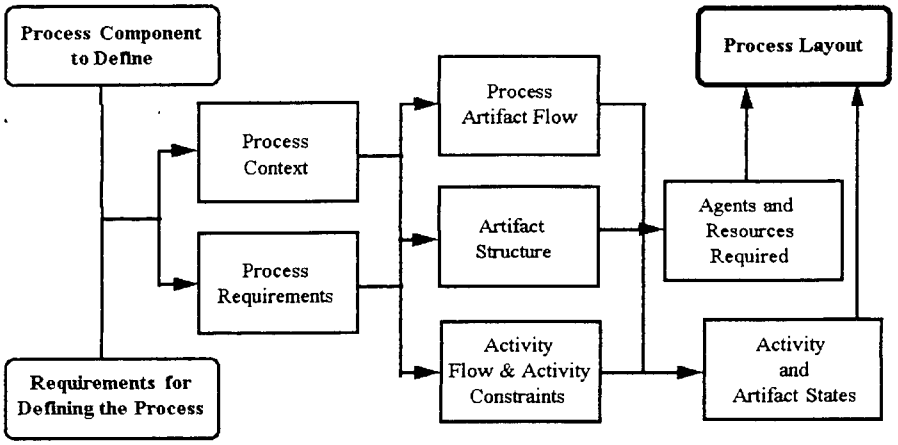
Process Definition



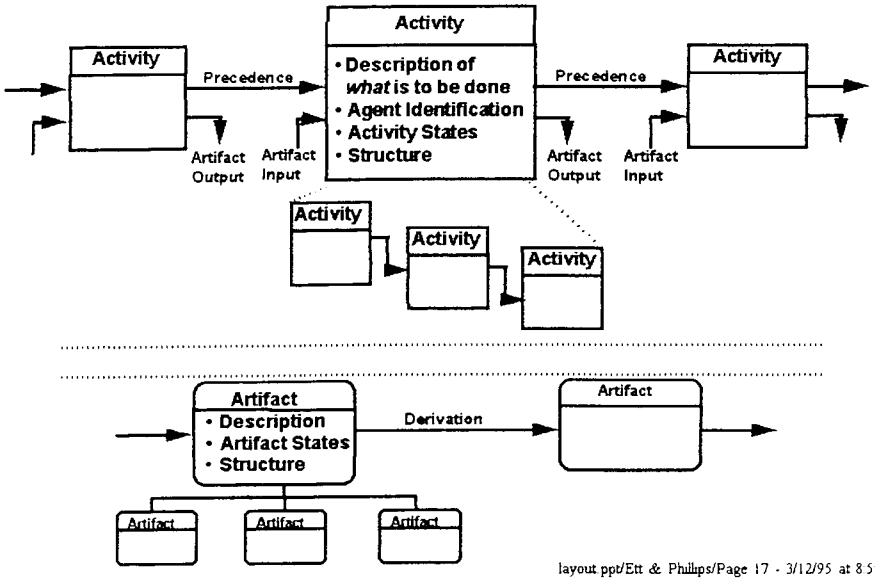
Process Definition, Evaluation & Use



Process Layout Objectives

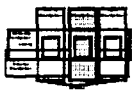


Process Layout Information



Describing the Artifacts of a Process

The important features of an artifact that should be described are:



Relationships	Behavior	Attributes
• structure and content • derivation • used or produced by activity • used or produced by agent	• artifact state • allowable state transitions	• purpose • description • requirements, goals, and measures • applicable specifications or standards

Artifact Structure

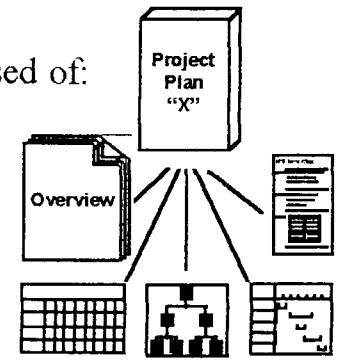
Describes the parts (components) of an artifact

- Artifact composition (part/subpart)

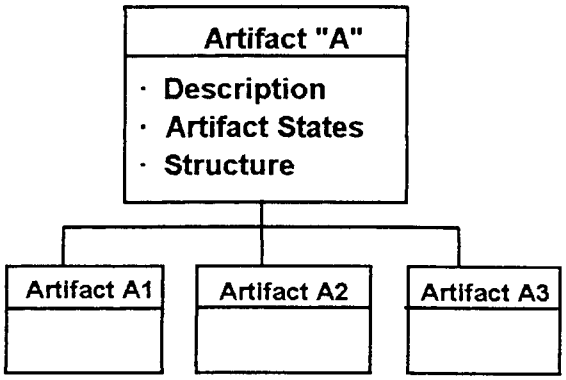
Artifact parts may themselves be artifacts

Example: Project Plan "X" is composed of:

- Overview section
- Work breakdown structure
- Size, effort, and cost estimates
- GANNT chart
- Methods/procedures



Artifact Structure



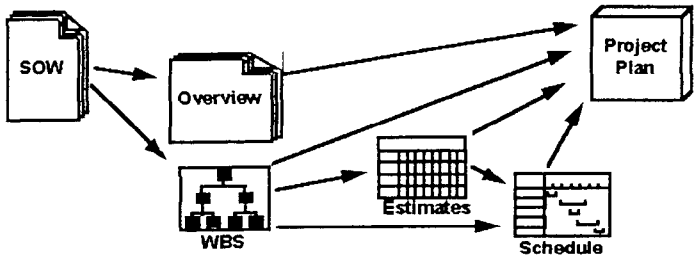
Artifact "A" has subparts "A1," "A2," and "A3."
Artifact "A1" is a subpart of Artifact "A."

Artifact Derivation

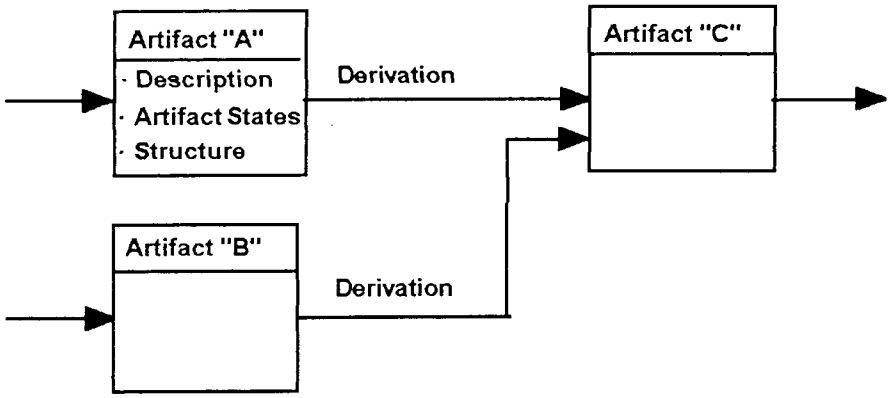
Describes ***precedence order*** based on the use of one artifact to ***derive*** another

For example:

- Project estimates are based on the WBS
- Project schedule is derived from the project effort estimates and the WBS



Artifact Derivation



Artifact "C" is derived from Artifact "A" and "B"

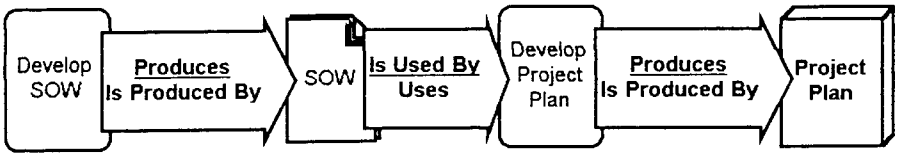
Artifact "A" is used to derive Artifact "C"

Artifacts Used and Produced

Activities have *inputs* and produce *outputs*

Examples of this relationship:

- Activity *Develop Project Plan* uses artifact *SOW*
- Activity *Develop Project Plan* produces *Project Plan*
- Artifact *SOW* is used by *Develop Project Plan*
- Artifact *Project Plan* is produced by *Develop Project Plan*

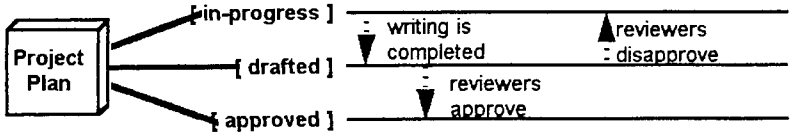


Artifact State

- Describes the phases (or states) of an artifact
- Transitioning from artifact state to artifact state describes the evolution of the artifact in the process

Example:

A project plan evolves from *in-progress* to *drafted*, and then to either *approved* or *in-progress*



Describing the Activities of a Process

The important features of an activity that should be described are:

Relationships	Behavior	Attributes
• artifacts used and produced • decomposition into sub-activities or procedures • dependencies among activities • activity control flow • performing agent	• activity state • entry criteria • exit criteria	• purpose • description • goals and measures • applicable polices

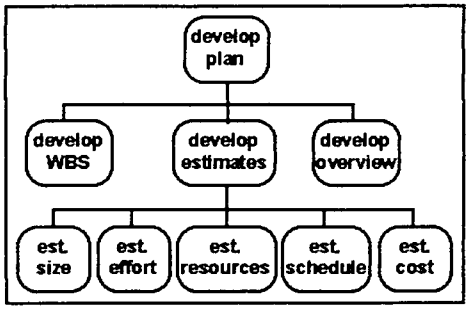
Activity Decomposition

Activities are decomposed into steps that are:

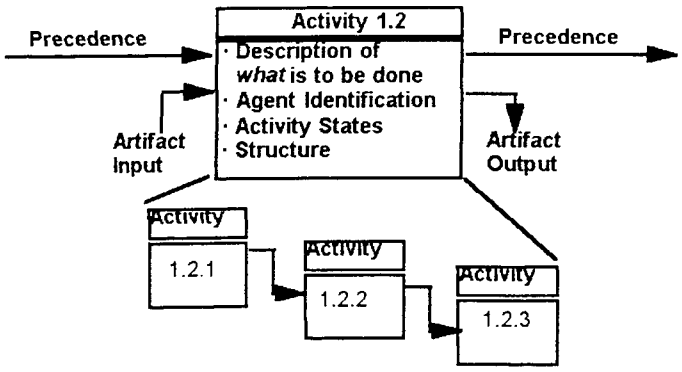
- Lower level sub-activities (tasks)
- Methods or procedures

Example:

1. Develop plan
   - 1.1 Develop WBS
   - 1.2 Develop estimates
     - 1.2.1 Estimate size
     - 1.2.2 Estimate effort
     - 1.2.3 Estimate resources
     - 1.2.4 Estimate schedule
     - 1.2.5 Estimate cost
   - 1.3 Develop overview



Activity Decomposition



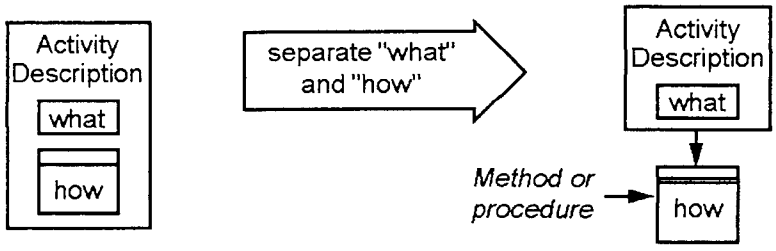
Activity 1.2 has sub-activities 1,2,1, 1.2.2, and 1.2.3

Activity 1.2.1 is a sub-activity of 1.2

Separating "What" and "How"

An activity is described by specifying:

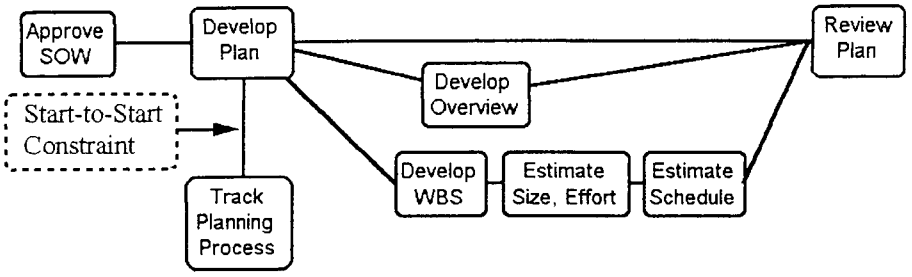
- **"what" happens and "how" it is done**
- The "how" component of an activity description should be defined in a *method or procedure* description separate from the activity description



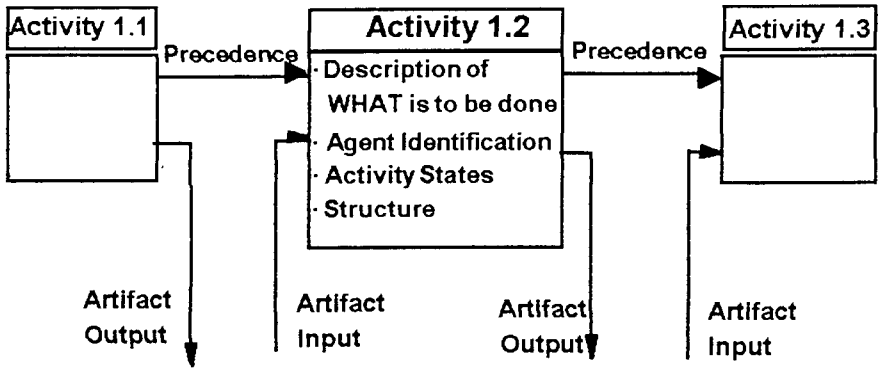
Activity Dependencies

Activity dependencies arise from:

- Artifact state or use, as well as activity state
- Decomposition of activities
- Coupling of activities
- Activity constraint relationships



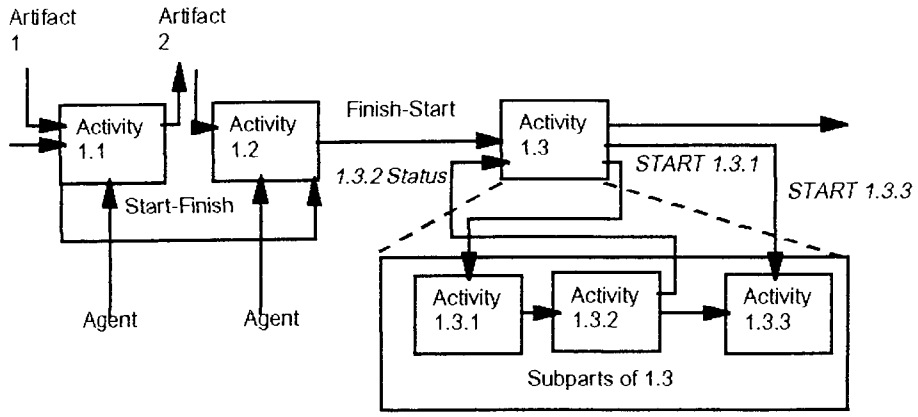
Activity Precedence



Activity 1.1 comes before Activity 1.2

Activity 1.2 comes after Activity 1.1

Activity Control

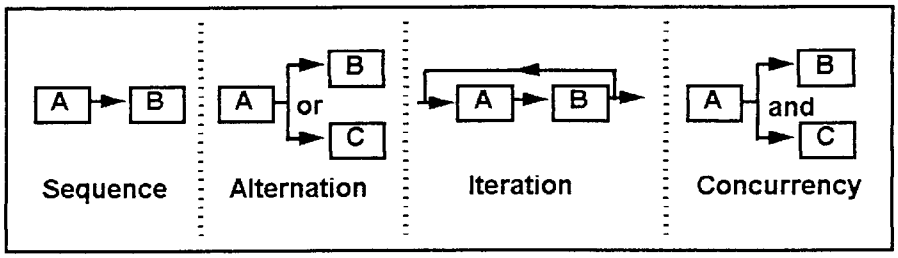


Activity 1.3 controls 1.3.1, 1.3.2 and 1.3.3.

Activity 1.3.1 is controlled by 1.3.

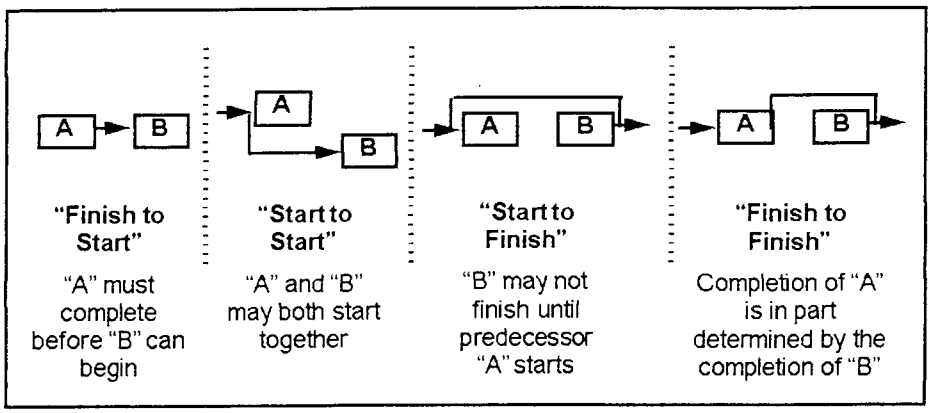
Activity Flow Relationships

Activity flow describes the static order of Activities

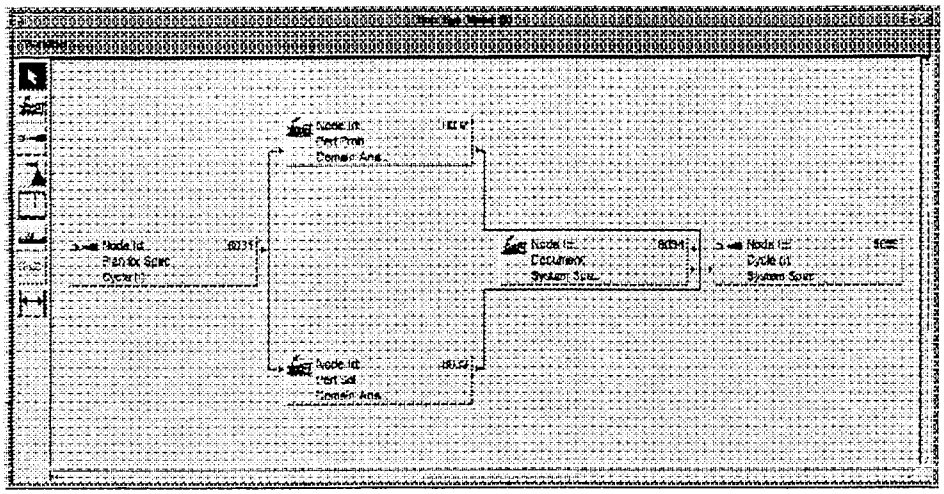


Activity Flow Relationships

Activity flow also describes the relationships and constraints between activities

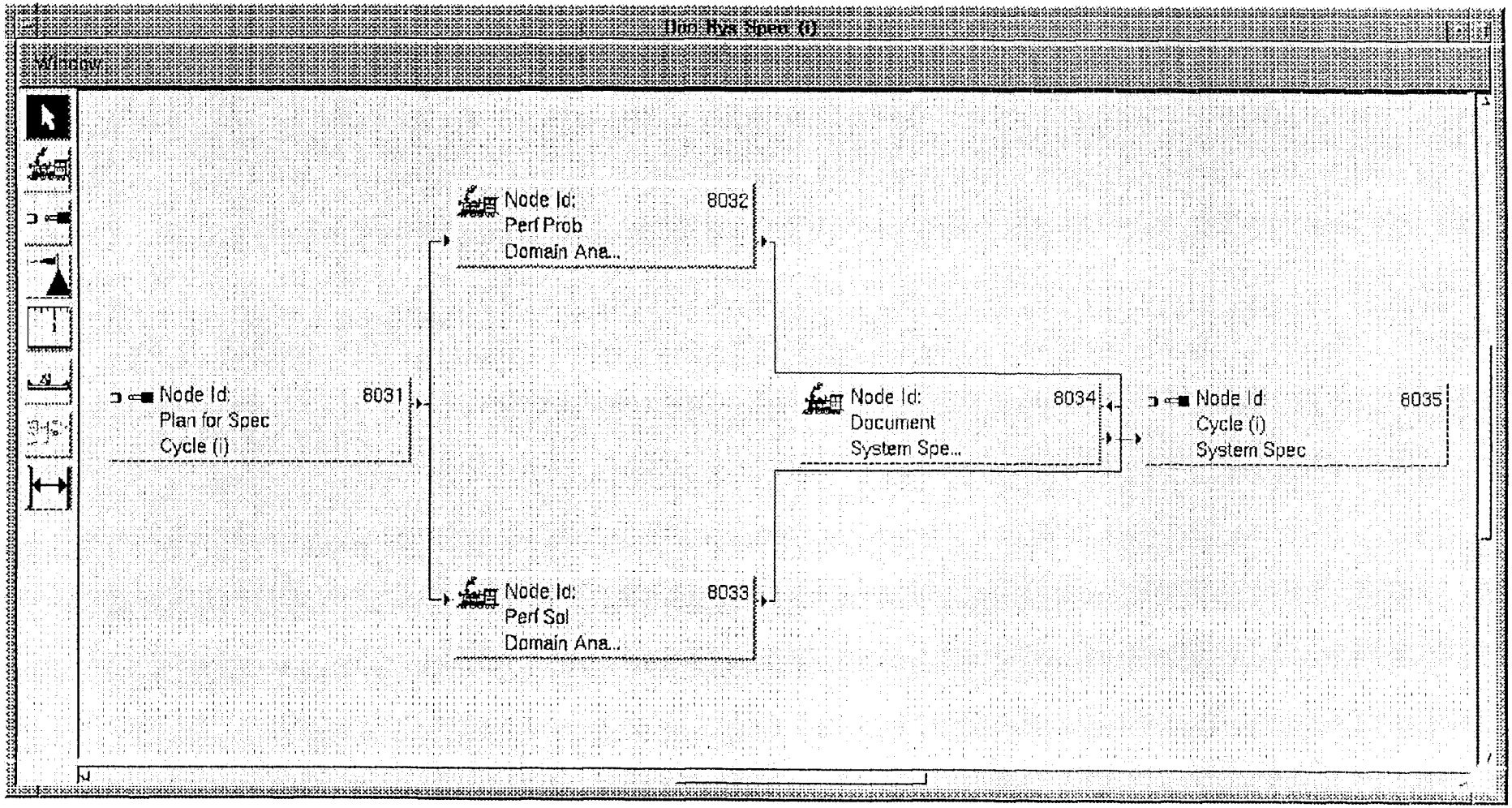


Activity Flow Relationships



"Finish to Finish" Link Example

Activity Flow Relationships

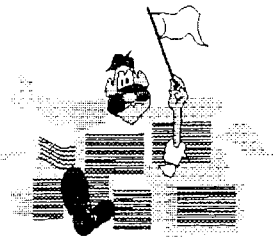


"Finish to Finish" Link Example

Parallelism Considerations

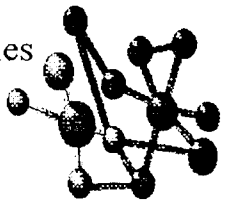
Typical software developer's state:

- Many activities in progress
- Few activities completed
- Tendency toward activity completions "bunching up" at major checkpoints



Process definer:

- Eliminate unnecessary serial dependencies
- Seek opportunities to enable multiple activities to be performed asynchronously
- Synchronize at milestones as necessary



Layout Granularity Considerations

- Some granularity factors
  - **Single Agent**
  - **Method intricacy**
  - **Practitioner expertise**
  - **Availability of subprocesses/methods**
  - **Characteristics of subprocesses/methods**
  - **Goals/purpose**
  - **Process/product state change logging points**
  - **Communication/navigation decision points**
  - **Project planning support requirements**

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Process Layout

Process Guide

Process Layout Section

Graphic Representation

- Artifact Goal State Map (artifact derivation flow)
  - Artifact structure
  - Artifact precedence
- Activity Network
  - Activity hierarchy
  - Activity precedence
  - Activity relation to artifacts (inputs/outputs)

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Process Layout

Process Guide

Process Layout Section

Textual Representation

For each activity of the process:

- Activity description
- Identification of supporting methods and states they may change
- Identification of required resources
- Identification of agents (roles) to perform/support the activity

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Process Layout

Organization/Project Repository Book

Artifacts and Goal States Section

Artifact Goal States

For each artifact, identify:

- Artifact state variables
- Allowable state transitions

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Layout Example

Refer to "*Process Definition Information Organizer Instructions*" Manual

Next Step: Process Design

For the assigned process:

- Verify that activity and artifact granularity is OK
- Completely describe all artifacts
- Completely describe all roles and their skill and experience requirements
- Define all required method descriptions

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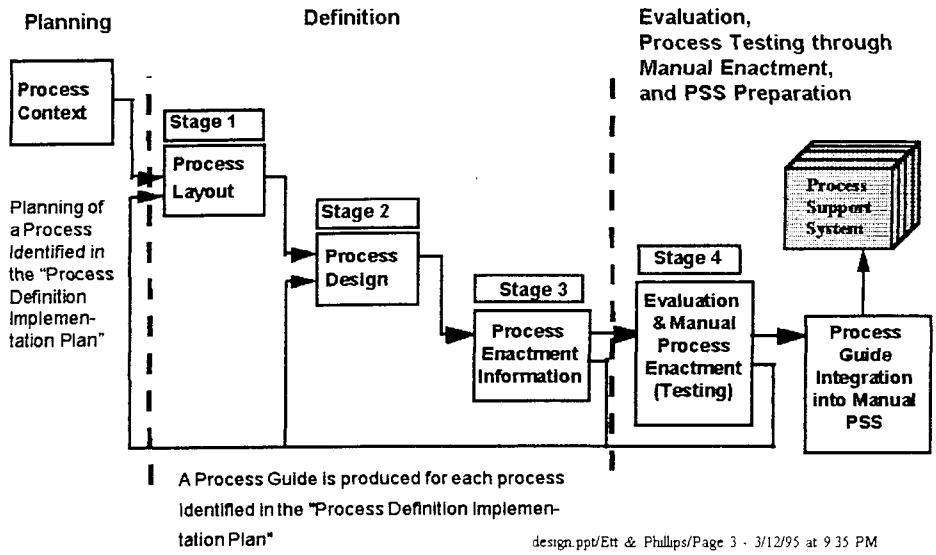
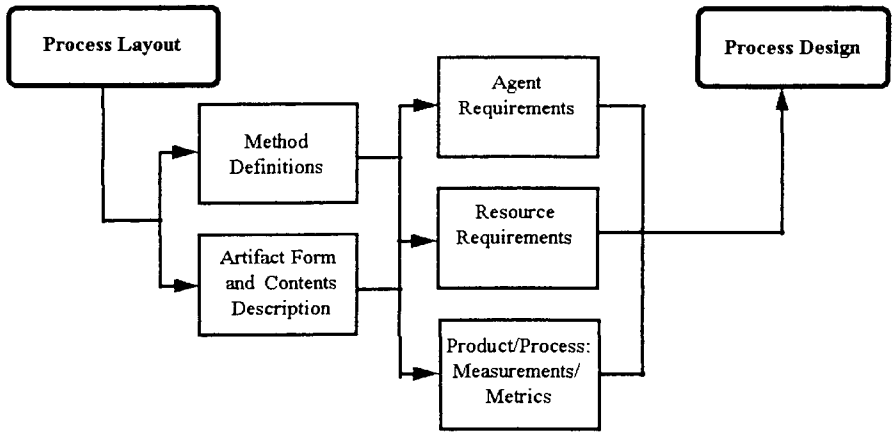
Process Design Specification

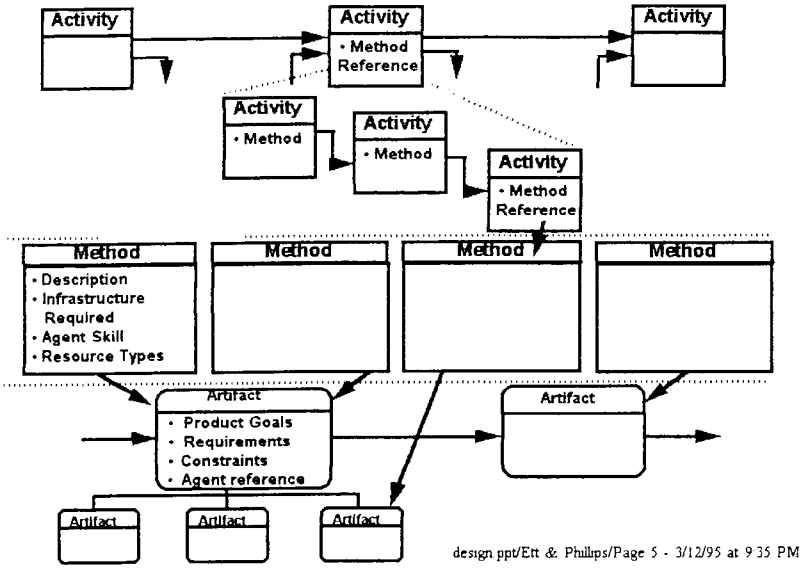
Process Definition, Evaluation & Use



Process Design Objectives



Process Design Information



Describing the Agents of a Process

The important features of an agent that should be described are:

Relationships	Behavior	Attributes
• organizational structure • activities performed • artifacts used and produced	• availability	• role • skills required • training required

Roles

Process definer: lays out the process, defines it, and creates the Process Guide

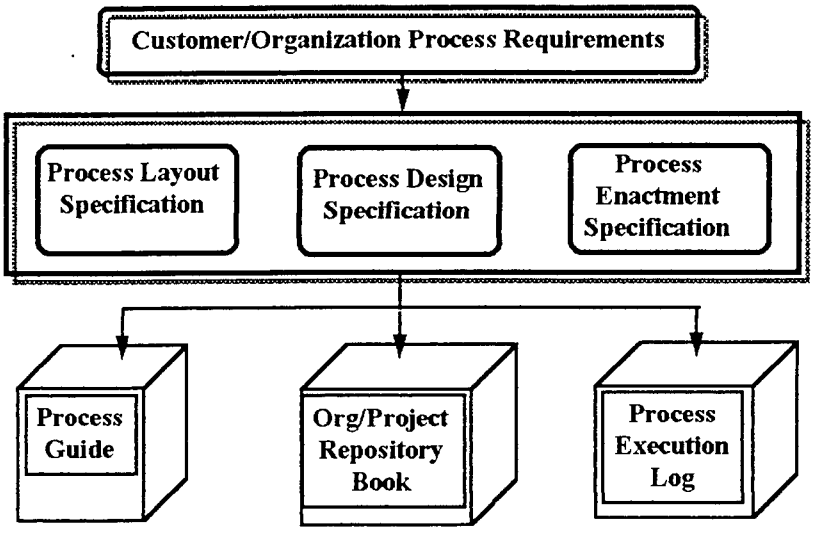
Practitioner: follows or executes/enacts the process definition

- Executive, Manager, Team Leader, QA, Engineer, etc.

Monitor: tracks and evaluates status and progress, anticipates future state

- Executive, Manager, Team Leader, QA, Engineer, etc.

Process Definition Products



Process Design

Organization/Project Repository Book

Artifacts and Goal States Section

Artifact Descriptive Information

- Artifact Purpose and scope
- Artifact Goals
- Artifact hierarchical structure (layout)
- Reference to artifact specification (Artifact DID)
  - Artifact organization
  - Artifact contents
- Artifact constraints
  Examples: Product standards, Drop dead dates, etc.

Process Design

Organization/Project Repository Book

Artifacts and Goal States Section

Artifact Owner and Constraints

- Artifact Owner/Author (role identification)
- Artifact Reviewer and Approvers (role identification)
- Artifact access privileges and constraints
- Reference to artifact specification (Artifact DID)
  - Artifact organization
  - Artifact contents

Process Design

Organization/Project Repository Book

Artifacts and Goal States Section

Artifact Owner and Constraints (Continued)

- Artifact constraints
  - Access permissions
  - How used/maintained
  - Who uses/maintains
- Artifact metrics to compute and collect

Process Design

Organization/Project Repository Book

Methods Section

Method Descriptive Information

- Method objectives
- Inputs used
- Outputs produced

Infrastructure Requirements

- Agent requirements (requisite skills, method training)
- Organizational and management support required
- Process system support functions required

Process Design

Organization/Project Repository Book

Methods Section (Continued)

Method Enactment Information
- How to achieve the objectives of the method
- How to report results

Agent Description Section

Agent role description
General experiences and skills required for the role
Types of resources the role requires

Design Example

Refer to Information Organizer Instructions

Next Step: Enactment Information Specification

- Add enactment work paradigm steps
- Draft "Process Guide"
- Refine granularity
- Refine detailed methods
- Complete "Process Guide"

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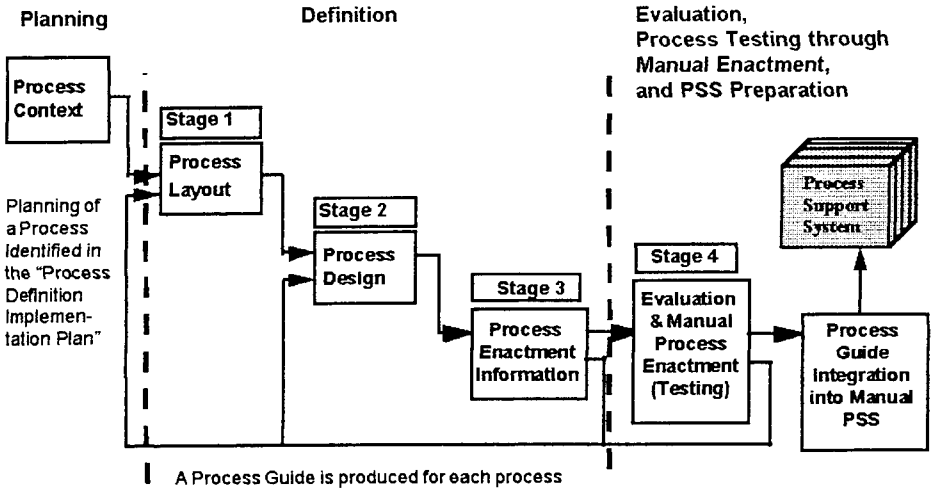
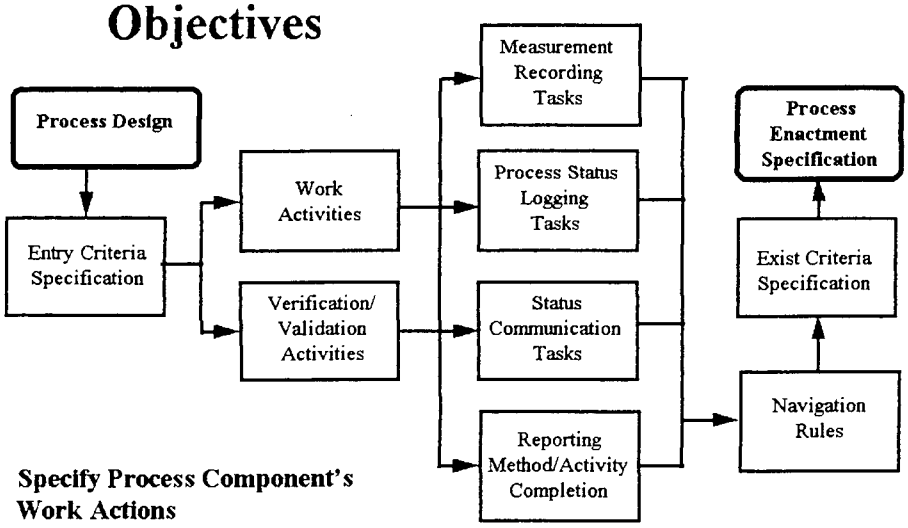
Process Enactment Information Specification

Process Definition, Evaluation & Use

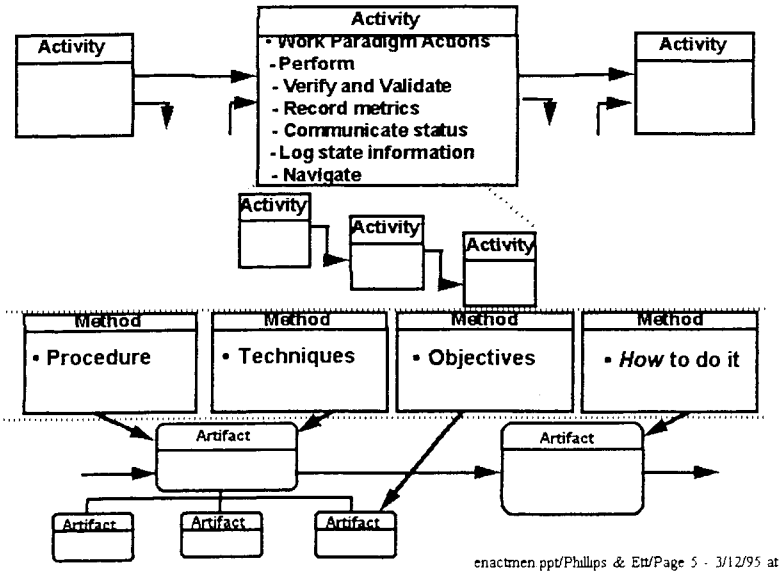


Process Enactment Specification Objectives



Specify Process Component's Work Actions

Process Enactment Information



Concept of a Work Paradigm

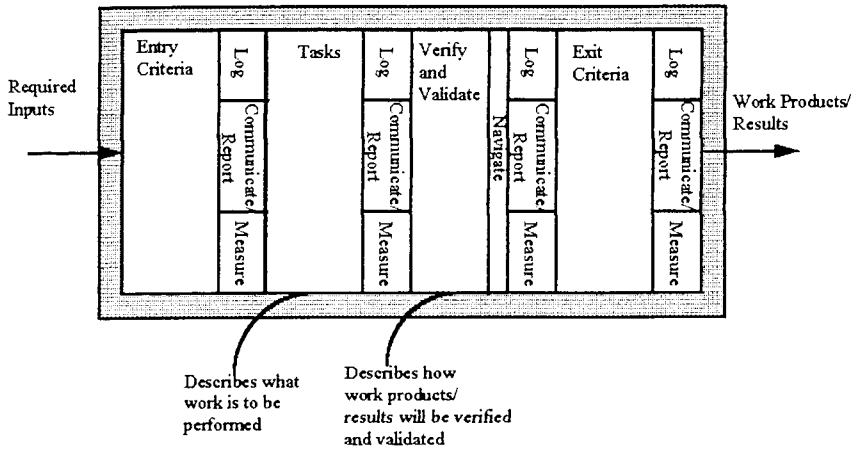
Work Paradigm

- Common set of actions to be performed within each activity
- General case across an organization or project

Example: "ETVX" paradigm

- Test Entry criteria
- Perform Task
- Verify/validate results
- Test eXit criteria

Extended ETVX Process Description



Example Work Paradigm Actions

Performing main task and *logging* Artifact state information for future navigation decisions

Verifying results against internal criteria

Validating results according to recipient needs

Recording process and product metrics for future improvement or contractual needs

Testing Exit Criteria and *logging* Activity status

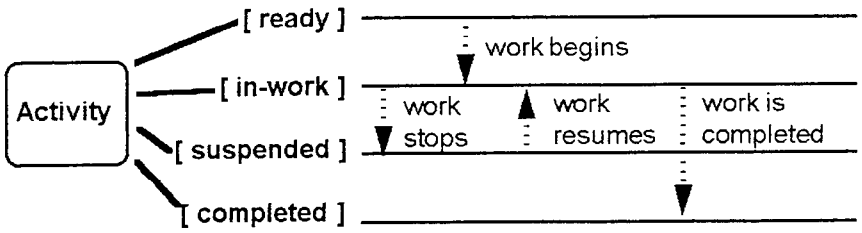
Communicating status to/from dependent work

Navigating to next defined activity based on current process/product state

Activity State and Allowed Transitions

Activity state can generally be described with these four states and the transitions:

- **Ready**
- **In-work**
- **Suspended**
- **Completed**



Activity Entry and Exit Criteria

Entry criteria define the conditions under which an activity is allowed to begin

Exit criteria define the conditions under which an activity can be declared complete, and are generally based on:

- Completion of an activity or output
- Availability of an input or agent
- Satisfaction of evaluation criteria
- State of an activity, artifact, or agent

Concepts of Behavioral Adaptability

Exceptions to prescribed process definition stem from real-life events

Process definition must carry adequate information to accommodate these situations

Example of process navigation needs that require behavioral adaptability:

- Iteration
- Rework
- Workahead

Mixed Initiative Considerations

Typical developer situation from following *information - based, creative* processes such as software development or product engineering:

- Many activities in progress
- Few completed
- Parallelism the norm

To support "real life" process pragmatics:

- Support/encourage *workahead* by means of ***permissive Entry Criteria***
- Enable *management control* through dependency network of ***rigid Exit Criteria***

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Optimal & Mandatory Entry Criteria

Entry criteria are either *optimal* or *mandatory*

Optimal entry criteria are those that *should* be met before the activity begins, but may be deferred to allow work-ahead

Mandatory entry criteria are those that *must* be met before the activity begins

Deferred entry criteria must be *satisfied before* the activity may be declared complete

Note: **exit criteria should always be mandatory**

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Process Enactment

Process Guide

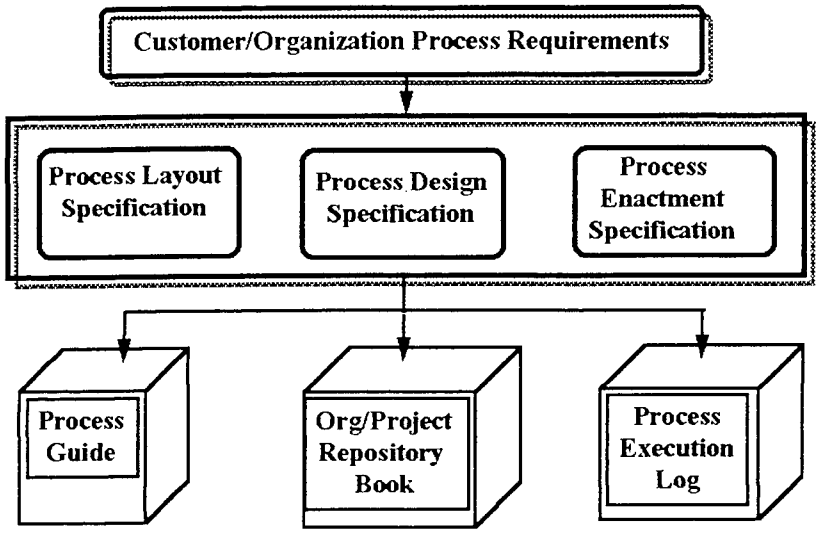
Process Enactment Section

For each activity in the process, specify -

Activity Work Paradigm Actions:

- **Test the entry criteria**
- **Perform the activity main task**
- **Verify main task results**
- **Validate main task results**
- **Record measurements and metrics**
- **Communicate process status**
- **Navigate to next activity**

Process Definition Products



Enactment Information Example

Refer to "*Process Definition Information Organizer Template*" Instructions Manual

Next Steps

- Complete enactment information
- Complete detailed methods
- Complete all artifact DIDs
- Complete Process Guides
- Prepare Project References and Execution Logs
- Review Process Guide, Organization/Repository Book entries, and Process Execution Log
  - Revise as appropriate
- Evaluate all process definition products

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Evaluating Process Definition Results

Discussion